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LOWER GREEN BAY: AN EVALUATION OF EXISTING AND HISTORICAL CONDITIONS

Earl Epstein, et al

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Documentation of the expected reduction in pollutant loads due to present control strategies is also provided. Field studies performed in this program indicate slight improvements in bay water quality over recent years. A water quality model, suitable for winter conditions, is also being developed which will allow predictions of improvement in bay water quality due to present and future pollution control strategies. The final report will be available in January, 1975.

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LOWER GREEN BAY: AN EVALUATION OF EXISTING AND HISTORICAL CONDITIONS

by

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Dale Patterson

WISCONSIN DEPARTMENT OF NATURAL RESOURCES

DIVISION OF ENVIRONMENTAL STANDARDS

In partial fulfillment of

EPA Contract No. 68-01-1572

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ENVIRONMENTAL PROTECTION AGENCY
Region V

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Report Number: EPA-905/9-74-006

EPA Project Officer: Howard Zar

August, 1974

This report has been developed under auspices of the Great Lakes Initiative Contract Program. The purpose of the Program is to obtain additional data regarding the present nature and trends in water quality, aquatic life, and waste loadings in areas of the Great Lakes with the worst water pollution problems. The data thus obtained is being used to assist in the development of waste discharge permits under provisions of the Federal Water Pollution Control Act Amendments of 1972 and in meeting commitments under the Great Lakes Water Quality Agreement between the U.S. and Canada for accelerated effort to abate and control water pollution in the Great Lakes.

This report has been reviewed by the Enforcement Division, Region V, Environmental Protection Agency and approved for publication. Approval does not signify that the contents necessarily reflect the views of the Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorcement or recommendation for use.

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ABSTRACT

A survey is made of current and historical information relating to the quality of the waters of Green Bay, Lake Michigan. The steady decline in water quality over the last four decades is documented. A historical shift in fish production from high quality native species to low quality exotic species has occurred. Increasing areas of the Bay exhibit low oxygen levels. In winter, under the ice, low oxygen levels now extend into the Bay as far as 40 kilometers. Nutrient loads have caused the areas where eutrophic conditions exist to increase. These and other factors have led to a dislocation of recreational use.

Documentation of the expected reduction in pollutant loads due to present control strategies is also provided. Field studies performed in this program indicate slight improvements in bay water quality over recent years. A water quality model, suitable for winter conditions, is also being developed which will allow predictions of improvement in bay water quality due to present and future pollution control strategies. The final report will be available in January, 1975.

SUMMARY

The change in nutrient loadings to Green Bay over the past thiry or forty years is difficult to document because of the paucity of data. The resulting algae growth has always been a part of the recorded history of Green Bay and may be associated with the origin of its name. In the recent two or three years the total algee growth may not have varied greatly but its extent and local concentration appear to have varied.

The Lower Fox River remains the largest source of nutrients and wastes for Green Bay. During the past twenty years pulp and paper production for mills along this river have approximately doubled. The BOD_5 and suspended solids discharge from these mills are now approximately what they were twenty years ago after an intermediate period of higher loadings. BOD_5 loadings from sewage treatment plants have risen in the past ten years along the Lower Fox River.

Several investigations have indicated that there is a counterclockwise circulation of the surface water in the southern end of Green Bay below the Oconto River and above Long Tail Point. It has been suggested that this current brings cleaner water down the western shore of the Bay while Fox River water follows the east side northward to Sturgeon Bay. It has been postulated that this movement creates two discreet water masses in lower Green Bay, one characteristic of the Fox River water and the other characteristic of the water of Green Bay. The division between these masses is Long Tail Point and the submerged bar extended towards it from the east.

Wind and current patterns play the most important roles in the mixing and transport of water within Green Bay. In the late fall and in the spring, winds from the direction of Lake Michigan bring in large quantities of fresh lake water which are trapped in the Bay. This influx may be less important than that from the input of lake water, driven by seiche motion, through the passages between the Bay and Lake Michigan. Green Bay becomes thermally stratified weeks before the adjacent deeper water of Lake Michigan. The effects of temperature and wind appear to make Green Bay into an independent lake separate from Lake Michigan.

Investigations of the type of bottom sediment in Green Bay show that an area at the extreme lower end of the Bay contains a high content of sewage sludge, derived from a combination of the inflowing Fox River and the outfall of the Green Bay sewage treatment plant. Brown silt was found to be common northeast of Long Tail Point and along the eastern shore. Brown mud, more cohesive than silt or the semifluid mud of the lower Bay, occured in the deeper water further north in the Bay. Bathymetric data from a 1968 survey was compared with the final work sheets of the U.S. Lake Survey for the Southern Bay (1943) and the Northern Bay (1950). In the region below Sturgeon Bay there were several areas where the bottom depth decreased substantially (two to four feet) over the brief period of seventeen years. The data were interpreted to indicate that Green Bay was filling in at a rate of 10 to 100 times that associated with larger bodies of water.

A historic change in the species composition of the commercial fish catch has occurred in Green Bay as well as in the Great Lakes in general. The early fishery (circa 1900) consisted of lake trout, white fish, lake herring, chubs, walleye and sturgeon. The present major commercial species are carp, smelt, alewife and perch. This represents a shift from high quality native species to low quality exotic species.

Several investigations of the bottom fauna of Green Bay have been carried out in the past 35 years. A recent, extensive investigation concluded with the view that if pollution of the Bay, via the Fox River, continues then a) the dominent species will, to an increasing extent, be associated with gross pollution, b) a larger abiotic area around the river mouth can be expected since conditions there have become unsuitable for even the pollution tolerant organisms, c) pollution intolerant midge larvae would be expected to decrease in abundance at stations farther north in the lower Bay and d) the pollution tolerant Oligochaete, the only group which increased in absolute and relative abundance in the past twenty years, would become even more important in the benthic community.

Dissloved oxygen concentrations in Green Bay appear to have decreased in the past thirty years. During warm weather, critical dissolved oxygen conditions are common on the Fox River and for a distance of 3-5 km into the Bay. In the colder months (from about mid-November into April), the dissolved oxygen in the river is generally in excess of 5 mg/l. However, during the winter and particularly after prolonged heavy ice cover, low dissolved oxygen concentrations can extend into Green Bay for distances of nearly 50 km. During the period of open water, reaeration causes a recovery of oxygen levels beyond the Long Tail Point area.

The majority of people who have contact with Green Bay do so in a recreational context. These people are often not aware of the many aspects of water quality which are important in the Bay. Water quality and characteristics as perceived by users rather than as monitored by scientists are important in decision making designed to improve the condition of the Bay.

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INTRODUCTION

This report consists of a survey of current and historical information about the quality of the waters of Green Bay, Lake Michigan. Some aspects of water quality are easier to define than others. For example, dissolved oxygen concentrations, biochemical oxygen demand, bottom fauna levels and nutrient additions to natural waters with the resultant growth of nuisance organisms are obvious subjects for the definition of the quality of water in Green Bay. These matters will be discussed in detail because they are most susceptible to quantitative measure. In addition, there are aspects of water quality which are less easily defined in a quantitative way. Among these are the mixing, transport, and dispersal of water in Green Bay, the changes in the commercial fishing industry, the constitution of the bottom sediments and public attitudes with respect to Green Bay. These subjects are important in any discussion of the long-term trends in Green Bay. The current and historical information about these subjects will also be reviewed. An attempt will be made to identify the relation between these factors and water quality.

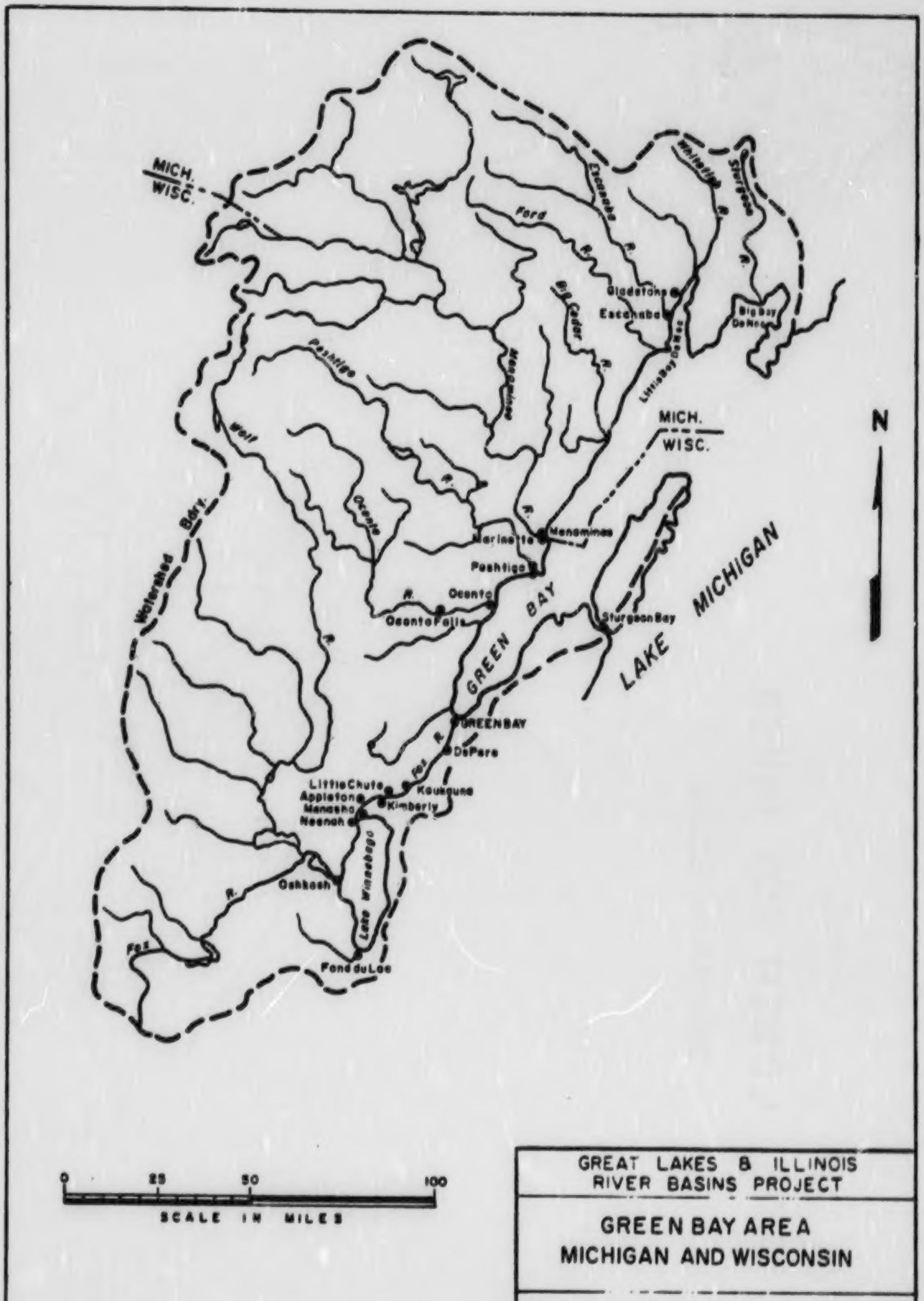
SETTING

Green Bay is a shallow estuary-like bay in the northwest corner of Lake Michigan. It is approximately 190 km long, with an average width of 37 km and has a mean depth of about 20 meters (U.S. Federal Water Pollution Control Administration, 1966). Only in a few places near the middle part of the Bay do depths exceed 60 meters; for the Bay as a whole, most depths are less than about 40 meters, and the western inshore region is less than about 18 meters deep. The principal axis of the Bay is oriented in a NNE-SSW direction. The Green Bay watershed contains a total drainage area of approximately 40,000 km^2, or about one-third of the total Lake Michigan basin. Approximately two-thirds of the watershed lies within Wisconsin, the remainder in Michigan (U.S. Federal Water Pollution Control Administration, 1966). The geographical setting of Green Bay is shown in Figure 1 along with the basins of the major tributary rivers.

Large concentrations of people and industry are characteristic of the Green Bay watershed, especially along the major tributary, the Lower Fox River. The most significant source of degraded water is the paper and pulp industry which discharges wastes with a population equivalent of 1,300,000 (Wisconsin Department of Natural Resources, 1973). The second major source of degraded water in the watershed is effluent from numerous municipal waste treatment plants. Combined storm and sanitary sewers in the larger communities contribute significantly to the waste problem.

Major rivers of Wisconsin which discharge into Green Bay are the Fox, Oconto, Peshtigo and the Menominee. The lower segment of the Menominee River marks the boundary between Michigan and Wisconsin and about 65 percent of its total drainage basin is located in Michigan. North of the Menominee River, the only significant discharges into the Bay are from the Cedar River and Little Bay de Noc which is the entryway for both the Whitefish and Escanaba Rivers. There are no

Figure 1a.



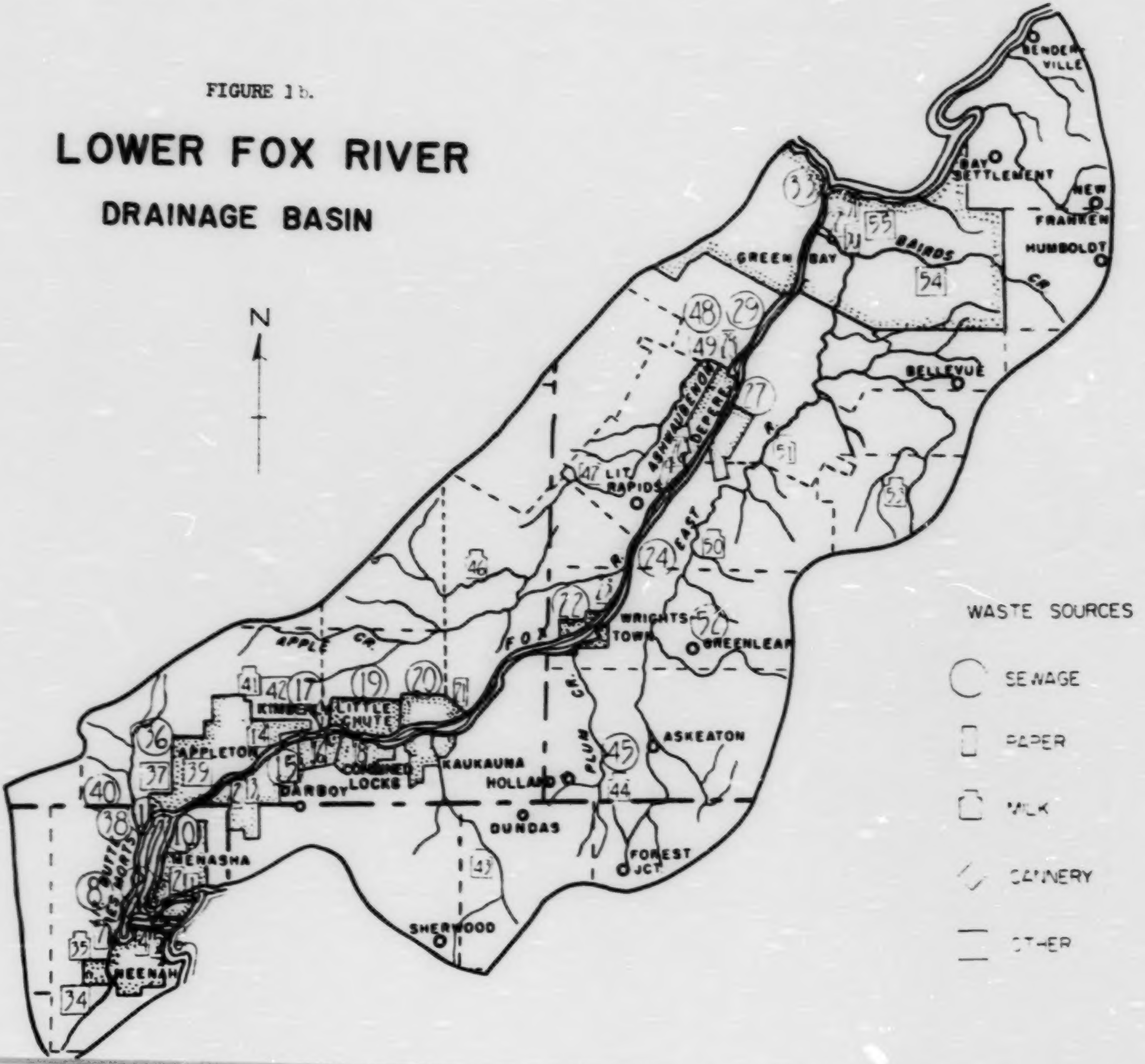
GREAT LAKES & ILLINOIS
RIVER BASINS PROJECT

GREEN BAY AREA
MICHIGAN AND WISCONSIN

US DEPT. OF HEALTH, EDUCATION, & WELFARE
FEDERAL WATER POLLUTION CONTROL ADMIN.
REGION CHICAGO, ILLINOIS

FIGURE 1b.

LOWER FOX RIVER
DRAINAGE BASIN



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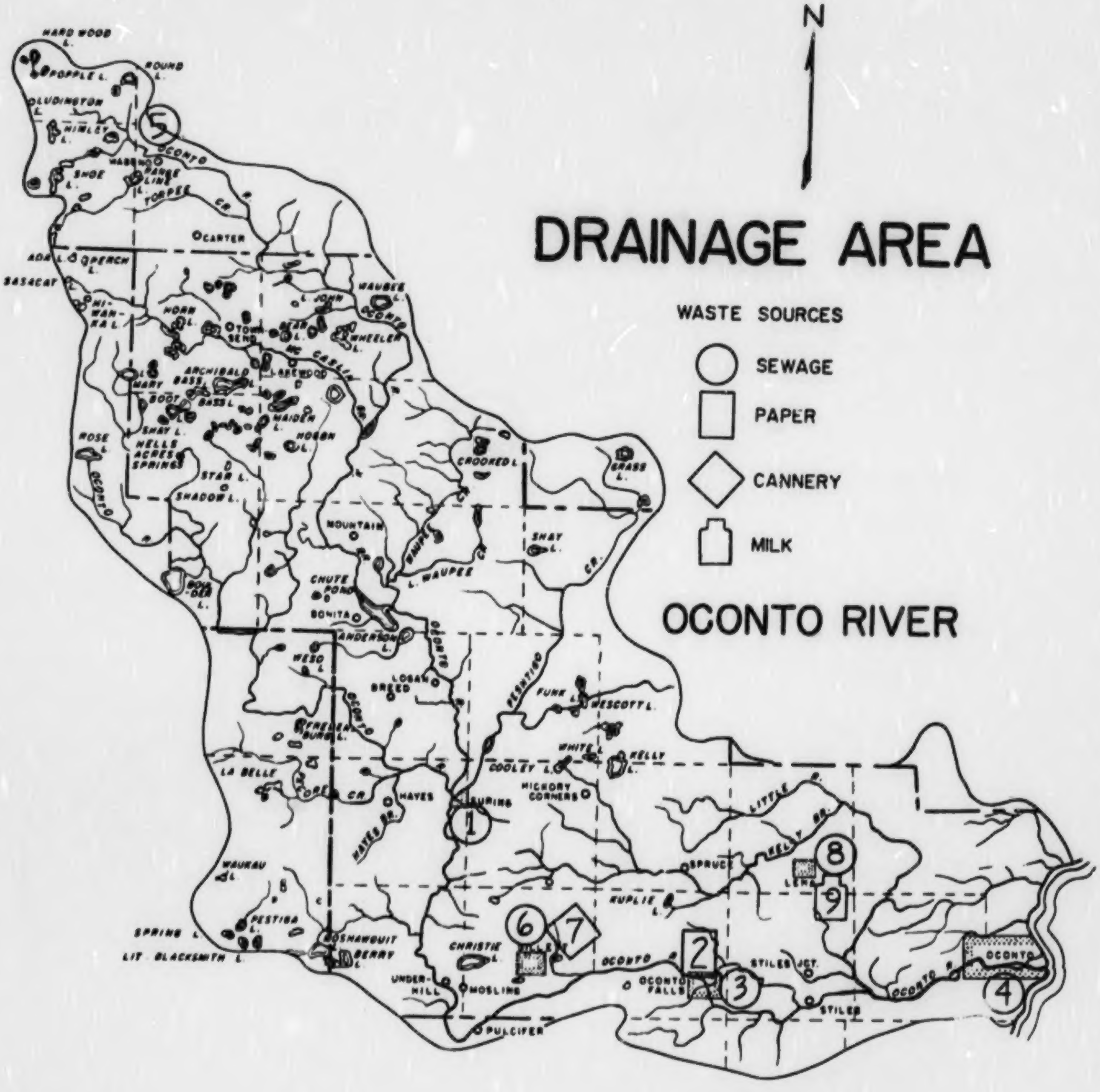
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RANGE LINE L.
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MC CASLIN
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LAKEWOOD
BASS L.
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MAIDEN L.
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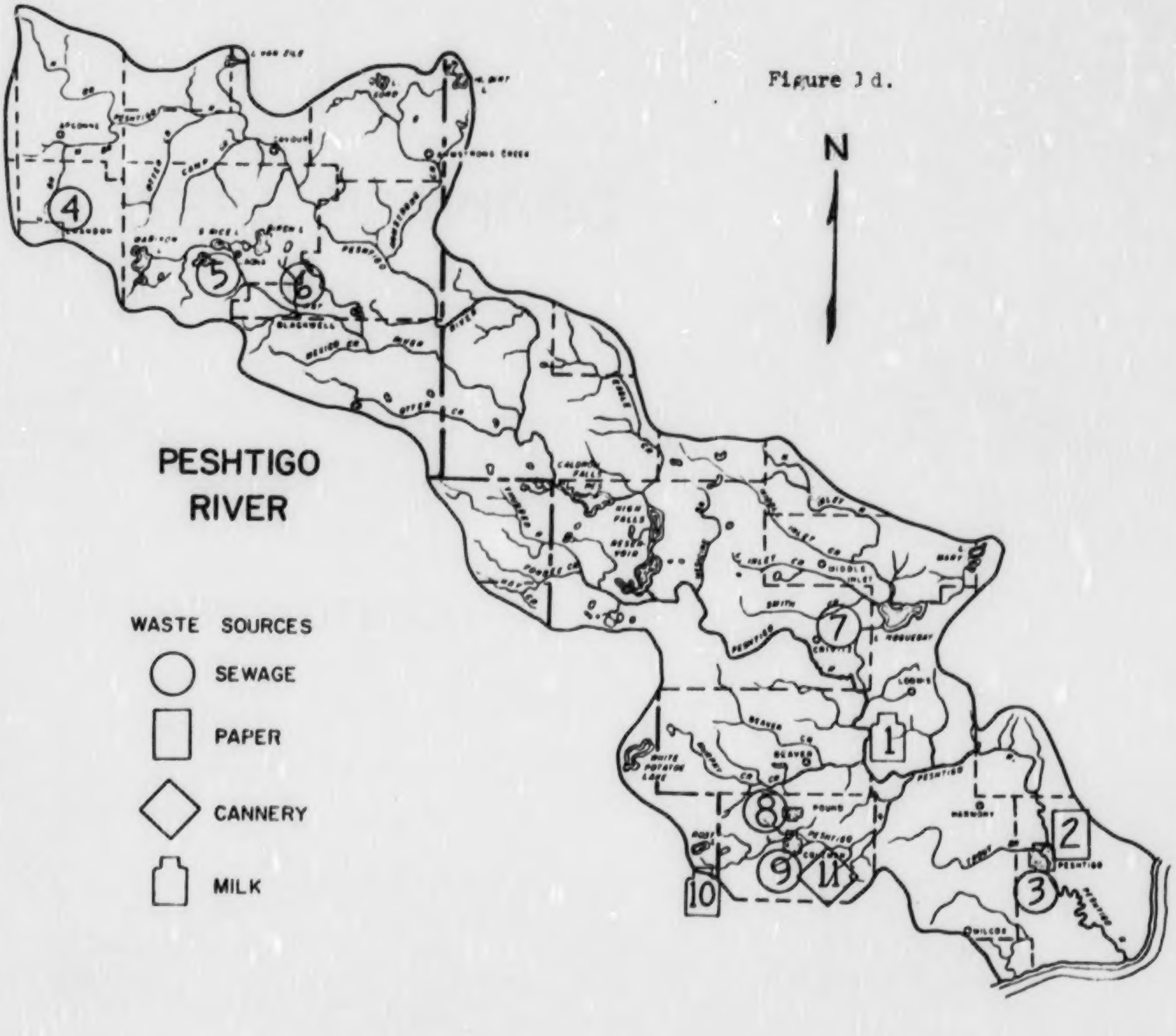
Figure 1d.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CRIVITZ
WHITE POTATOE LAKE
HARMONY
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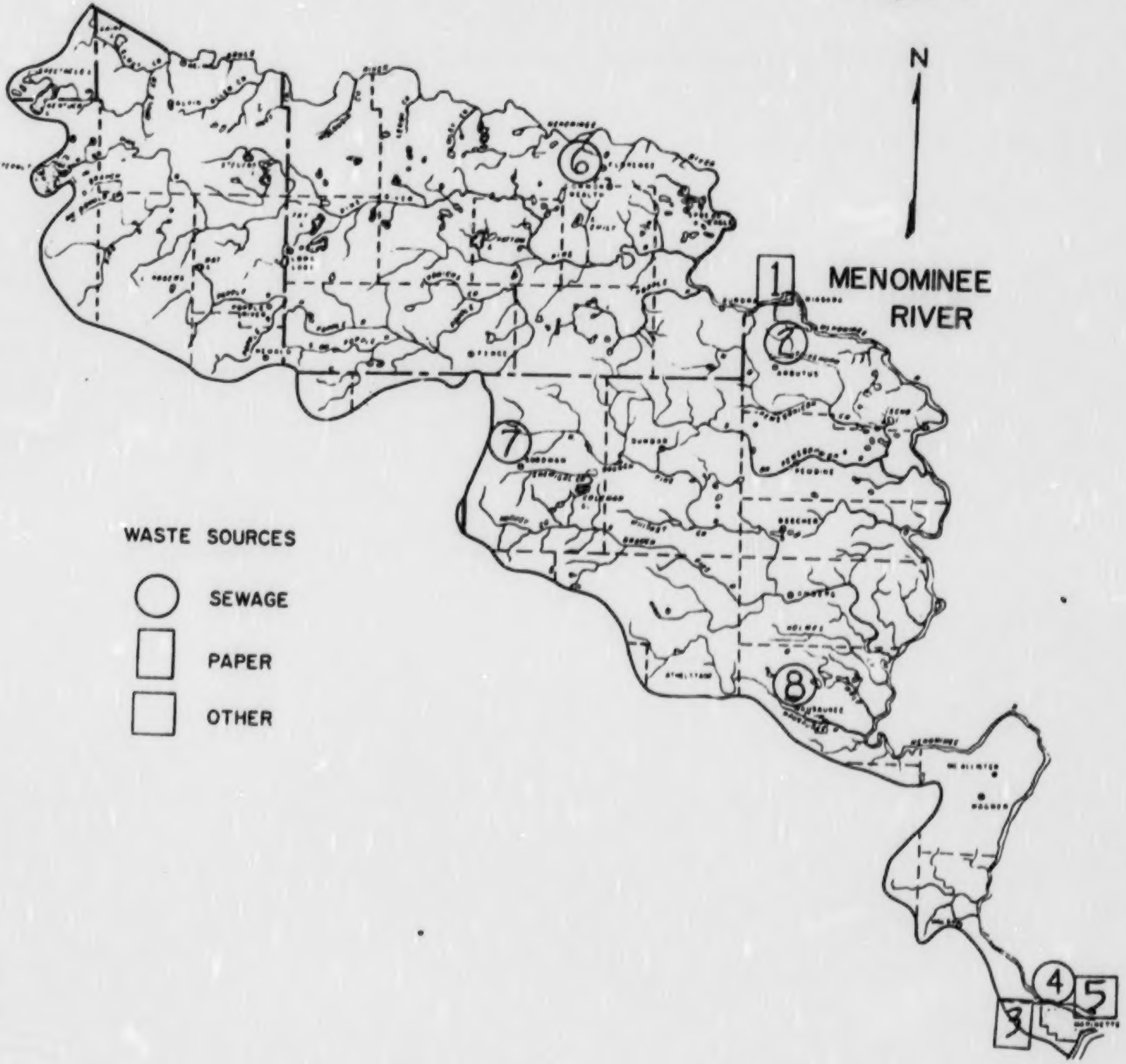
OTTER CR.
BEAVER CR.
SMITH CR.
MIDDLE INLET
LOOMIS
WILCOX

Figure 1e.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WASTE SOURCES
SEWAGE
PAPER
OTHER

significant streams draining into Green Bay east of the Fox River. Smaller streams tributary to the Bay on the west and north of the Fox include Duck Creek, Suamico River and Pensaukee River. All carry silt and some carry industrial debris.

The drainage areas of the major tributaries to Green Bay are shown in Table 1.

TABLE 1. DRAINAGE AREAS--MAJOR TRIBUTARIES OF GREEN BAY.*

Stream	Length	Drainage Area	Mean Discharge
Fox	322 km	16,687 km^2	117 m^3/sec
Menominee	193	10,748	88
Peshtigo	233	2,991	24
Oconto	209	2,416	16
Escanaba	185	2,382	25
Whitefish	-	816	-
Cedar	-	-	2

*U.S. Federal Water Pollution Control Administration, 1966.

Problems of water quality are most severe at the southern tip of Green Bay adjacent to the mouth of the Fox River. Other regions of degraded water quality are at the mouths of the Oconto, Peshtigo, Menominee and Escanaba Rivers.

NUTRIENTS AND THEIR EFFECT ON NATURAL WATER SYSTEMS

Organic and inorganic complexes of carbon, nitrogen and phosphorus function as nutrients and/or buffers in natural waters. Complex relationships exist between algal blooms and concentrations of these nutrients. Micronutrients such as iron, cobalt, zinc, molybdenum, silica and others, in addition to sodium, potassium and calcium, also play a role in the growth of algae in natural waters. Buffering capacity is important in controlling the chemical availability of carbon, nitrogen, phosphorus and trace elements. In enriched waters, the buffering capacity could be increased directly by the addition of charged compounds and indirectly by the amino acids, organic acids and CO_2 resulting from increased biological activity. Since the enzymatic reactions which regulate the growth of algae are often pH dependent, biological activity would be favored in situations where precipitous changes in pH are prevented.

The following macroscopic factors must be considered in a complete discussion of nutrients in natural waters:

1. the analytical detection of increased amounts of nutrients,
2. measureable and often explosive increases in algal populations,
3. a decreased transparency in natural waters which affects photosynthesis,
4. in thermally stratified deep lakes, gruadually decreasing dissolved oxygen in the bottom waters,
5. decreased organism diversity, sometimes proceeded briefly by increasing diversity,
6. appearance of new, undesirable species and disappearance of old ones,
7. increasing silting and accelerating accumulation of bottom sediments.

A discussion of the algal growth in Green Bay must deal with many, if not all, of these factors. Nutrient availability is but a single, though exceedingly important, factor. The historical performance of numerous lakes verify that the extent of production generally is related to nutrient concentration (Thomas, 1969;

Rodhe, 1969). Simply, nutrient-rich lakes are expected to produce large algal crops. The following table (Table 2) defines the concept of enriched waters in terms of the photosynthetic rates of free-floating algae (Phytoplankton) that occur in response to increasing nutrient concentrations.

TABLE 2. PHOTOSYNTHETIC RATES OF PHYTOPLANKTON IN OLIGOTROPHIC AND EUTROPHIC LAKES, mgC/m^2 day

	Oligotrophic	Eutrophic Natural	Polluted
Mean rates in growing season	30 - 100	300 - 1,000	1,500 - 3,000
Annual rates	7 - 25	75 - 250	350 - 700

(Bartsch, 1972)

Increased amounts of nitrogen and phosphorus have been suggested as the primary cause of algal blooms because these nutrients are generally found to be limiting in concentration in natural waters. Of these two, phosphorus is most often found to be the element whose concentration is the limiting factor in algal blooms. Although the importance of carbon in regulating algal growth has long been known, it received little attention until recently (Kerr et al, 1970; Kuentzel, 1969; Lange, 1967). Increased supplies of carbon (as well as nitrogen and phosphorus) are needed to support continued algal growth. The availability of large concentrations of CO_2 generally preclude conditions in which carbon becomes the limiting nutrient in aquatic systems. Only under unusual conditions will carbon be a limiting nutrient. The availability of these growth nutrients depends upon physical parameters such as pH, temperature and light, as well as rates of supply and demand. Specific rates for chemical reactions in the environment are among the least known of these parameters.

Bartsch (1972) has discussed the problem of eutrophication control. The primary question becomes which nutrient or nutrients should be eliminated, to what degree and by what method. The recent "Symposium on Nutrients and

Eutrophication--The Limiting Nutrient Controversy" (American Society of Limnology and Oceanography, 1972) dealt with this problem. It was generally agreed by the participants that the only realistic option for controlling or reversing cultural eutrophication in lakes is to remove phosphorus from the waters which supply these lakes. The theory that carbon should be regarded as the nutrient which is growth limiting under some conditions and should be the focus of control attempts (Lange, 1967; Keuntzel, 1969; Kerr, 1970) was rejected as generally nonapplicable. Vallentyne (1970) has pointed out that carbon is too ubiquitous to be controlled. Efforts by Morton et al (1971) to control algae growth by CO_2 control were not successful in waters open to the atmosphere. Nitrogen is only partly controllable because of the many sources (for example, blue-green algae can fix N_2 directly from the air when fixed nitrogen is the limiting nutrient). It was concluded that phosphorus can be controlled by an adjustment of human affairs. The most practical method appears to be removal of phosphorus in municipal waste treatment plants. Current practical methods for this removal also have the added significant advantage of an accompanying reduction in BOD levels.

Carbon

Plants require large amounts of carbon and are incapable of growing on their cellular carbon compounds. Conversely, these plants require small amounts of nitrogen and phosphorus and possess the capability for growth on cellular nitrogen and phosphorus compounds.

In aquatic ecosystems, plants require carbon in the form of CO_2 and HCO_3^- for growth (Allen, 1952; Hoare and Moore, 1965; Pearce and Carr, 1967). Oxidation of organic material and carbon dioxide in the air provide the extensive concentrations of CO_2 and HCO_3^-. The primary processes involving carbon which occur in aquatic ecosystems may be summarized as follows:

RESPIRATION: Organic Compounds + O_2 $\xrightarrow{\text{bacteria}}$ $CO_2 + H_2O$

PHOTOSYNTHESIS: $CO_2 + H_2$ $\xrightarrow{\text{bacteria}}$ Organic Compounds + O_2

Addition of organic carbon should stimulate the growth of the bacteria which are necessary for these conversions. The bacterial organisms utilize several forms of organic carbon for growth (unlike the algae which utilize CO_2 or HCO_3^-) and are more efficient than the algae in removing the phosphorus from water (Rigler, 1956). The photosynthetic process generates carbohydrate complexes which are used for growth by algae cells and other aquatic life. Phosphorus is used for the storage of energy in phosphate bonds when adenosine triphosphate (ATP) and other phosphorus-containing residues are formed. The oxidation of carbonaceous material produces CO_2 which tends to lower the pH of the aquatic system according to the following:

$$CO_2 + H_2O \rightleftharpoons H^+ + HCO_3^- \rightleftharpoons H^+ + CO_3^{2-}$$

Under anaerobic conditions which exist at various times in Green Bay and in the Fox River, the carbon in organic material is converted into methane.

Nitrogen

It has been suggested that NH_4^+ may be the form of nitrogen which is absorbed at the molecular level by cells (see Brezonik et al, 1973, for a summary of this point). This is the form of ammonia which is present in highest concentration in acidic or well-buffered, slightly basic systems because of the equilibrium:

$$NH_4^+ \rightleftharpoons NH_3 + H^+ \qquad pKa = 9.3$$

Buffering capacity is important in the control of the chemical availability of carbon, nitrogen, phosphorus and trace elements. The addition of charged ions, amino acids, other organic acids, and other species as the result of increased biological activity contributes to a well-buffered system. Thus, the oxidation of organic matter tends to stabilize the pH of natural waters, a stabilization which further enhances the conditions for algal growth.

Rainfall contributes nitrogen in the form of NO_3^- to natural waters. The decomposition of organic matter under aerobic or anaerobic conditions produces ammonia (NH_3). The direct fixation of N_2 by blue-green algae contributes to the nitrogen budget of natural waters.

Under aerobic conditions, oxidation of ammonia occurs according to the following reactions:

$$2NH_3 + 3O_2 \xrightarrow{\text{bacteria}} 2H^+ + 2NO_2^- + 2H_2O$$

$$2HNO_2 + O_2 \xrightarrow{\text{bacteria}} 2H^+ + 2NO_3^-$$

$$NH_3 \xrightarrow{\text{nitrification}} NO_3^-$$

This nitrification process provides the primary mechanism whereby the ammonia generated by organic decomposition is removed from aquatic systems. Failure to maintain oxygen levels leads to a buildup of ammonia concentrations which eventually become lethal to aquatic organisms. The buildup of ammonia concentrations also impedes the recovery from low oxygen levels.

The reduction and removal of NO_3^- can occur in a denitrification process. The NO_3^- is reduced to N_2. The consensus now is that denitrification occurs at significant rates when oxygen is absent from the system or at least sufficiently low enough to allow anoxic enzymes to develop (Brezonik et al, 1973). Reduction of NO_3^- to N_2 is accompanied by the oxidation of organic matter to CO_2. The net process is exothermic. Since the cells have no means for storing the energy released in this process, the use of NO_3^- rather than NH_3 (or NH_4^+) for the assimilation of nitrogen by plants is wasteful of energy.

The natural processes under aerobic conditions (oxidation of organic material) favor the assimilation of nitrogen in the form of NH_4^+. These processes tend to maintain well-buffered systems or to slightly reduce pH. Excess concentrations of ammonia are removed via nitrification to NO_3^-. Unfortunately, in lower Green Bay, anoxic conditions may contribute to the buildup of concentrations of ammonia which are lethal to fish.

Phosphorus

Since phosphorus is generally the growth limiting nutrient in many natural water systems, its role is examined in greater detail. Phosphorus exists in natural waters in various forms. Orthophosphate (PO_4^{3-}) and phosphite (PO_2^-) appear in agricultural runoff. There are several condensed phosphates, including pyrophosphate ($P_2O_7^{4-}$), metaphosphate (PO_3^-) and polyphosphate ($P_3O_{10}^{5-}$). Polyphosphate, as the sodium salt, is a major component of many modern detergents. The term organically bound phosphate is reserved for all organophosphorus compounds.

The role of phosphorus in metabolism of algae is related to the storage of energy. In the photosynthesis process, light converts inorganic phosphate into residues such as adenosine triphosphate (ATP) in organic molecules. The oxidation of organic material releases considerable amounts of energy. For example, the process glucose + $O_2 \longrightarrow CO_2 + H_2O$ has a $\Delta H = 268 \frac{\text{kcal}}{\text{mole}}$. This energy is stored in cellular molecules as phosphate bonds in subgroups such as ATP. This stored energy may be used as a driving force in many other metabolic reactions.

Phosphorus is generally absorbed by algae as PO_4^{3-}. However, at least some algae have the necessary enzymes to convert more complex phosphate compounds to orthophosphate to facilitate absorption. Much of the phosphorus incorporated into algal cells occurs as polyphosphate. The algae are capable of "luxury uptake" of phosphorus (uptake greater than that required for growth).

It is not known if "luxury uptake" is a universal capability of algae or exists only in a limited number of species. Laboratory observations have shown that some algae are able to continue through several reproductive generations without added phosphorus input (Bartsch, 1972). This has no lasting impact on eutrophication because growth depends upon useable or available phosphorus at the appropriate time in the cells in the water. Live algae will not share their adequate or surplus nutrients with nutrient-limited algae. Once a nutrient is tied up with living algae, that nutrient is not available for other plants until the original dies (Fitzgerald, 1971). Phosphorus comes off rapidly when algae die. Nitrogen does not come out and the nitrogen is not readily available to other algae without a long period of degradation. The extent to which growth due to phosphorus storage occurs under natural conditions is not well established, but laboratory studies indicated population increases of more than a month with some algae (Levin, 1963). "Luxury uptake" leads eventually to some settling out of phosphorus compounds when algae die. Lund (1950) has suggested that Asterionella, which contains luxury amounts of phosphorus, sinks to the deeper waters where the growth of the organism is regulated by decreased light. During the spring turnover, these cells serve as the inoculum for that season's population. Thus, cells contain luxury amounts of phosphorus at the beginning of the growing season.

Phosphate may be lost at high pH by precipitation with counterions such as Ca^{2+} or Fe^{2+}. These precipitated phosphorus compounds are available for algal growth. The release of phosphorus from sediments may be considerable and appears to be more rapid under anaerobic rather than aerobic conditions (Fitzgerald, 1971). This point will be discussed in greater detail in the following section which is concerned with the specifics of phosphorus loadings to Green Bay. The rate of equilibration between soluble and insoluble forms of phosphorus compounds is generally faster than the algae growth rate. Thus the solubility of phosphorus compounds does not appear to be a limiting factor for the growth of algae. As an example of this, laboratory studies have shown that teeth can support algae growth (Fitzgerald, 1971).

Both aquatic plants (algae) and bacteria absorb phosphorus. Rigler (1956) has estimated that about 75 percent of absorbed phosphorus is found in bacteria rather than algae.

Mixed algae populations contain carbon, nitrogen, and phosphorus in a weight ratio approximating 41:7.2:1 (Bartsch, 1972). The essential nutrient present in least supply relative to need will limit growth and thus determine the size of the algal crop. If the environment offers 82 weight units of carbon, 14.4 of nitrogen, but only one of phosphorus, growth will be limited by a deficiency of phosphorus. Adding phosphorus in abundance at this point via sewage or otherwise will destroy its growth regulating function. This is now what is happening at many localities in this country.

A closely related concern is the gradual decrease in the nitrogen/phosphorus ratio as natural waters receive sewage and/or other high phosphorus-bearing pollutants. The added phosphorus reaches an excess and is no longer growth-limiting. On the basis of studies on 40 European lakes, Thomas (1969) concluded that "It is certain that oligotrophic (nutrient-poor) lakes on which man has had little or no influence all have phosphate as the limiting factor." Vallentyne (1970) has reported that addition of phosphate can increase algae that form the basis of fish food supplies. Increased fish yields of from 50 to 500 percent may follow. The following ratios have been suggested as measures of eutrophication (Bartsch, 1972).

	N/P
Oligotrophic	15 or more -- Phosphorus limited
Eutrophic	Around 5
Polluted	2-3 -- No longer P-limited

Bartsch (1972) has reviewed sources of phosphorus throughout the nation. Among the results are the following:

(a) under optimal operating conditions, the effluent from an activated sludge plant has a typical N/P ratio of 2 to 3. The ratio of N/P for the Green Bay municipal sewage treatment plant effluent was less than 1 for the period October, 1970 - October, 1971. From January, 1971 to January, 1972, the Fox River provided a N/P ratio of nutrients to Green Bay of approximately 18. The total input of phosphorus in all forms was approximately 6,000 kg during this period (Sager and Wiersma, 1972);

(b) the phosphorus content of domestic sewage is about 3 to 4 times the level found before the advent of synthetic detergents at about 1945 (Stumm and Morgan, 1962). Sawyer (1952) estimated the 1950 detergent industry contribution at about 1.6 lb. P/person/year. A 1955 estimate was 1.9 lb. P/person/year (Engelbrecht and Morgan, 1959). A task force estimate for 1958 gives 2.1 pounds (anon., 1967). Phosphorus consumption in detergent formulations is second only to consumption in fertilizers;

(c) while a national average is unavailable, a recent source (Prince and Bruce, 1971) estimates that approximately 50 percent of the municipal phosphate discharge in Canada to Lakes Erie and Ontario is from detergents. In the U.S., the corresponding figure is 70 percent. Based on these values, it is estimated that detergent phosphorus accounts for 40 percent of the total input into the two lakes.

Algae Growth in Green Bay

Chlorophyll a has been used as measure of the extent of algae growth in Green Bay in several recent surveys. Generally, low concentrations of orthophosphate and nitrate are found in the summer and fall, compared to other seasons of the year. This is the period of the year when high densities of phytoplankton are found. Rousar and Beeton (1973) measured chlorophyll a concentrations on July 12, 1971 at 21 stations in lower Green Bay. They found values which ranged from 7.0 to 14.4 ug/l.

For the period June-August, 1971, Sager (personal communication to Rousar and Beeton) measured chlorophyll a concentrations which ranged from 1.2 to 57.4 ug/l (average 21.9 ug/l). Seven stations were sampled from near the mouth of the Fox River and extending to about 65 km north of the river. The highest values were found near the mouth of the Fox River with steep concentration gradients in the lower Bay. Monthly samples at the confluence of the Fox River with Green Bay from June, 1970 to October, 1971 yielded a range of 0.2 to 80 ug chlorophyll a/liter (average 24). Rousar and Beeton (1973) speculate that the noticeable lower results obtained by Sager may be related to differing sample handling techniques.

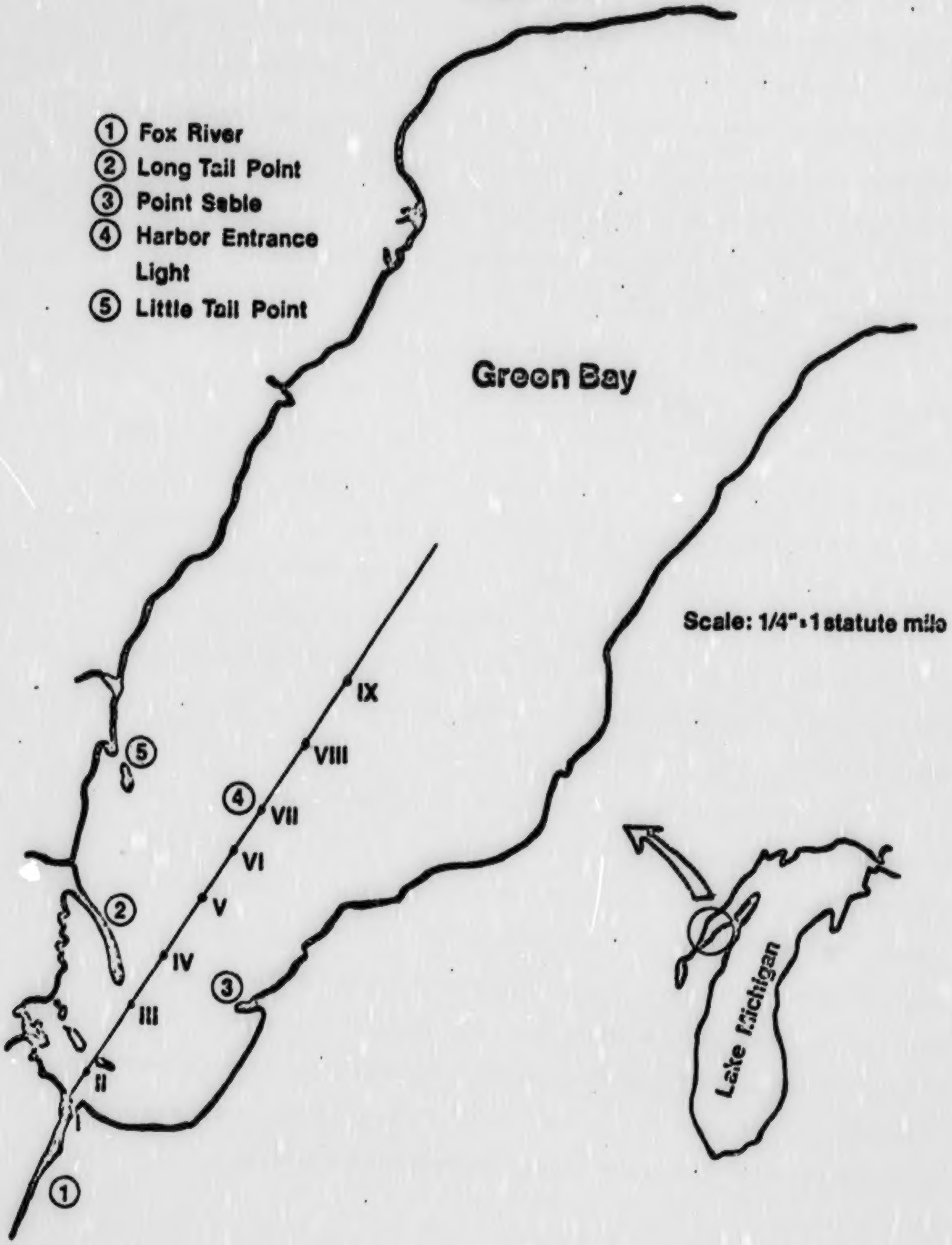
Schraufnagel et al (1968) found that algae blooms were generally confined to the inner Bay area in the summer of 1966. Blooms were observed only occasionally between the 10-mile light (16 km) and the 48 km station. Beyond 64 km planktonic algae blooms were not noted. The nutrient data is moderately consistent with planktonic algae observations.

Holland (1969) measured chlorophyll a concentration at three stations situated 32 to 48 km from the south end of the Bay from April to November, 1965, and obtained an average of 10.4 ug/l. From the same region, Rousar and Beeton (1973) found an average of 18.6 ug/l in July, 1971.

Sager (1971) studied the nutritional ecology and community structure of the phytoplankton of Green Bay in the summer of 1970 at nine stations which extended 21.5 km into the Bay (see Figure 2). He found the highest concentrations of algae (as measured by both chlorophyll a and as dry weight of plankton) in the region 2.5 to 8 km from the mouth of the Fox River. There was a low uptake in phosphorus by phytoplankton in the presence of high soluble phosphate (PO_4^{3-}) concentrations. A relationship was suggested to exist between a bloom of the nitrogen-fixing blue-green algae *Aphanizomenon*

Figure 2.

Summer, 1971



flos-aquae on August 12 and a surge of phosphate-rich water from the Fox River on July 22. The position where the bloom occurred and the timing of this bloom are consistent with an estimated flushing time of 29 days for this region (Modlin and Beeton, 1970). In general, an inverse relationship was found to exist between luxury uptake of phosphorus and high phosphorus concentration in the water. Measurements suggested the existence of two water masses in the lower bay, one characterized by Fox River parameters and the other representing the bay water.

Vanderhoef et al (1972, 1973) have used acetylene reduction as a measure nitrogen-fixation in relation to nutrient levels in Green Bay. They have measured the concentrations of nutrients as well as algae growth at several stations in lower Green Bay in 1971 and 1972. An individual species approach was used rather than a community approach in an attempt to assess the response of the Bay waters to nutrient loadings. Acetylene reduction activity closely correlated with population increases of blue-green algae, primarily species of Aphanizomenon and Anabaena, and these population increases occurred at sites where the soluble phosphate concentration was high. Their conclusions were many and specific:

(a) High soluble phosphate concentrations preceded all major increases in heterocystis nitrogen-fixing blue-green algae. If high concentrations of soluble phosphate are present and if the concentration of fixed nitrogen is the limiting factor in the growth of species which do not fix nitrogen, then the competitiveness of nitrogen-fixing blue-green algae may be increased. Large increases in fixed nitrogen lagged the large phosphate increases. During blooms of nitrogen-fixing algae, soluble phosphate concentration decreased considerably (concentrations of 30-50 ug P/l fell to 10 ug P/l or less). Acetylene reduction was never high where soluble phosphate concentration was less than 12 ug P/l.

(b) Periodic increases in soluble phosphate concentration promotes the growth of nitrogen-fixing algae. Seasonal mixing mobilizes nutrients. Phosphate concentration is probably the limiting factor in the growth of nitrogen-fixing species of algae in Green Bay.

(c) Fluctuations in the concentrations of nitrate, nitrite and ammonium ion do not correlate with fluctuations in nitrogen-fixing activity nor with the total amount of algae. Temperature variations do not correlate with nitrogen-fixing activity.

(d) Iron is present in the waters of Green Bay and plays a role in the nutrient balance. Phosphate removal methods take out both iron and phosphate. Phosphate removal by wastewater treatment is more likely to control algal bloom formation than is phosphate removal from detergents alone.

(e) The contribution of fixed nitrogen by nitrogen fixation in the inne 725 km^2 of the Bay was estimated to be close to 40 percent of the total inorganic nitrogen ($NH_4^+ + NO_3^-$) contributed by the Fox River during the period between June 14 and August 17, 1972.

These studies by Vanderhoef et al (1972, 1973) suggest that an investigation of species response to nutrient loadings may be a useful approach to the question of algae growth in Green Bay.

NUTRIENT AND WASTE LOADINGS AND THEIR EFFECT ON THE FOX RIVER AND GREEN BAY

Municipal and Industrial Waste Loadings to the Fox River

The Wisconsin Department of Natural Resources and its predecessor agencies, in cooperation with the pulp and paper industry, have collected information essential for the determination of the effect of liquid wastes on the Fox, Oconto, Peshtigo and Menominee Rivers and Green Bay. Some of this information for industrial and municipal waste dischargers is summarized in Appendices I-V. Appendix I contains past pulp and paper mill production and past and projected waste loadings for the years 1950-1977. For these mills, the present and proposed waste treatment facilities are presented in Appendix II.

The past and projected river loadings by municipal sewage treatment plants (1948-1978) along the Lower Fox, Oconto, Peshtigo and Menominee Rivers are presented in Appendix III. These data are in the form of discharge, BOD, suspended solids and nitrogen loadings to these rivers. Present and proposed waste treatment facilities, for the treatment plants along these rivers are listed in Appendix IV.

For the years 1966-1968, a comprehensive point source and stream survey was carried out on the Lower Fox, Oconto, Peshtigo and Menominee Rivers. This information is summarized in Appendix V. Reference to this data shows that for 1967, the total BOD_5 loading to the Lower Fox River from mill, municipal plant and other industrial or manufacturing sources was 315,000 lb/day of which less than 10 percent was from municipal treatment plants. Appendix VI presents the surface water quality data for the years 1950-1973 for the Lower Fox, Oconto, Peshtigo and Menominee Rivers.

Figure 3 summarizes past pulp and paper mill production and past and projected discharge data (BOD and suspended solids) for the years 1950-1977. Projected data comes from the interim effluent guidelines associated with the Wisconsin Pollutant Discharge Elimination System (WPDES). It should be noted that during the late 1950's, the committee on water pollution revised its sample handling and analysis procedures with the result that five-day biochemical oxygen demand (BOD_5) test results reported prior to about 1958 are lower, by as much as 20 percent, than their actual values. All BOD_5 values reported in the appendices are nonadjusted figures. Sewage treatment plant loadings to the Lower Fox River (BOD and discharge rate) are summarized in Figure 4 for 1956, 1966, 1973 and 1977 (projected).

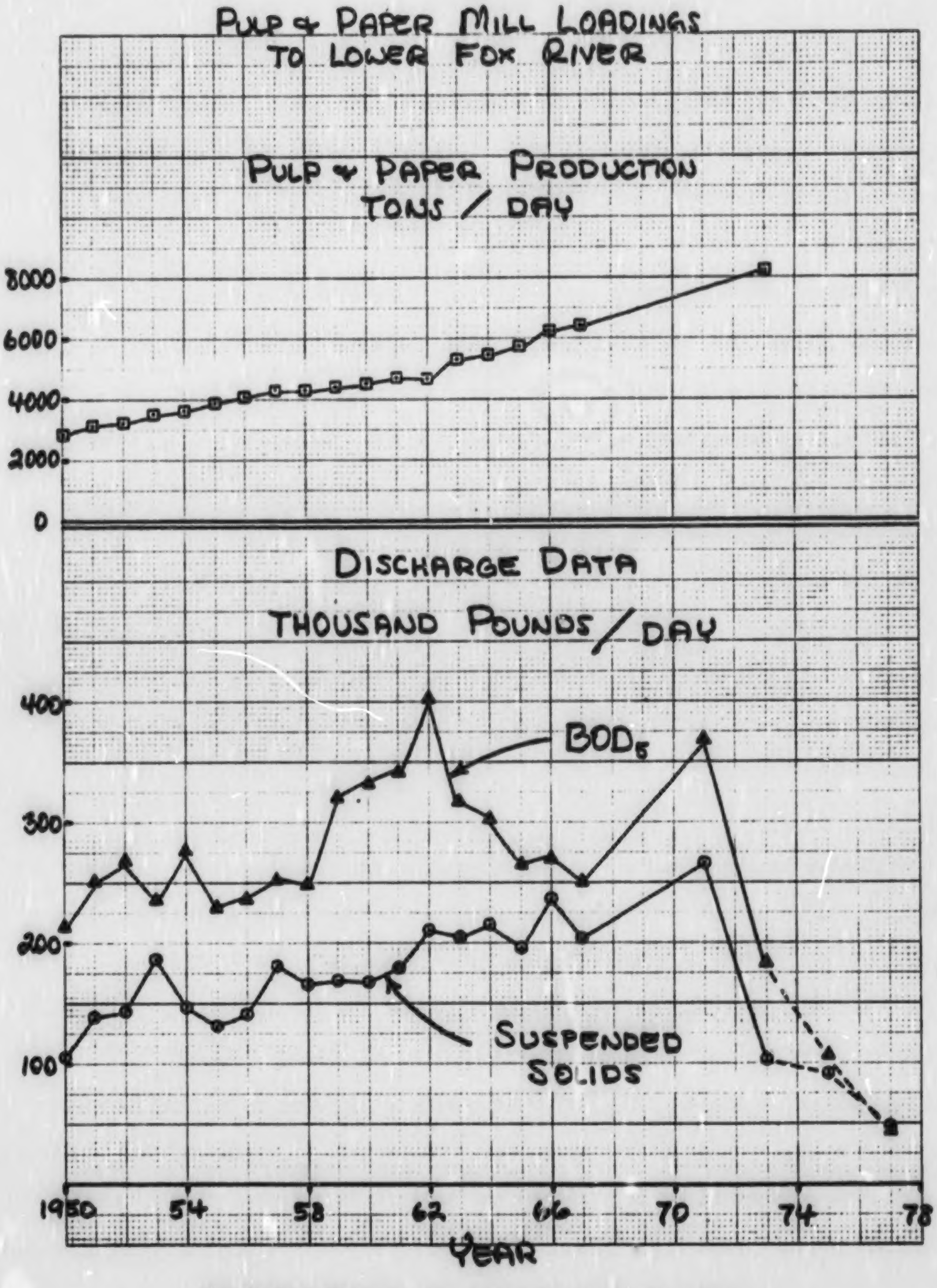
Nutrient loadings to the Lower Fox River by pulp and paper mills and by municipal treatment plants for 1971 are presented in Tables 3 and 4. Table 4 includes data from nine of the eleven municipal treatment plants investigated by Sager and Wiersma (1972), those nine for which additional historical data exists.

Phosphorus Loadings

Available nitrogen and available phosphorus are conceded to be the most important and necessary nutritional components for excessive aquatic growths and eutrophic conditions. Participants in a symposium on nutrients and eutrophication (American Society of Limnology and Oceanography, 1972) concluded that phosphorus most often is the limiting nutrient in algal growth.

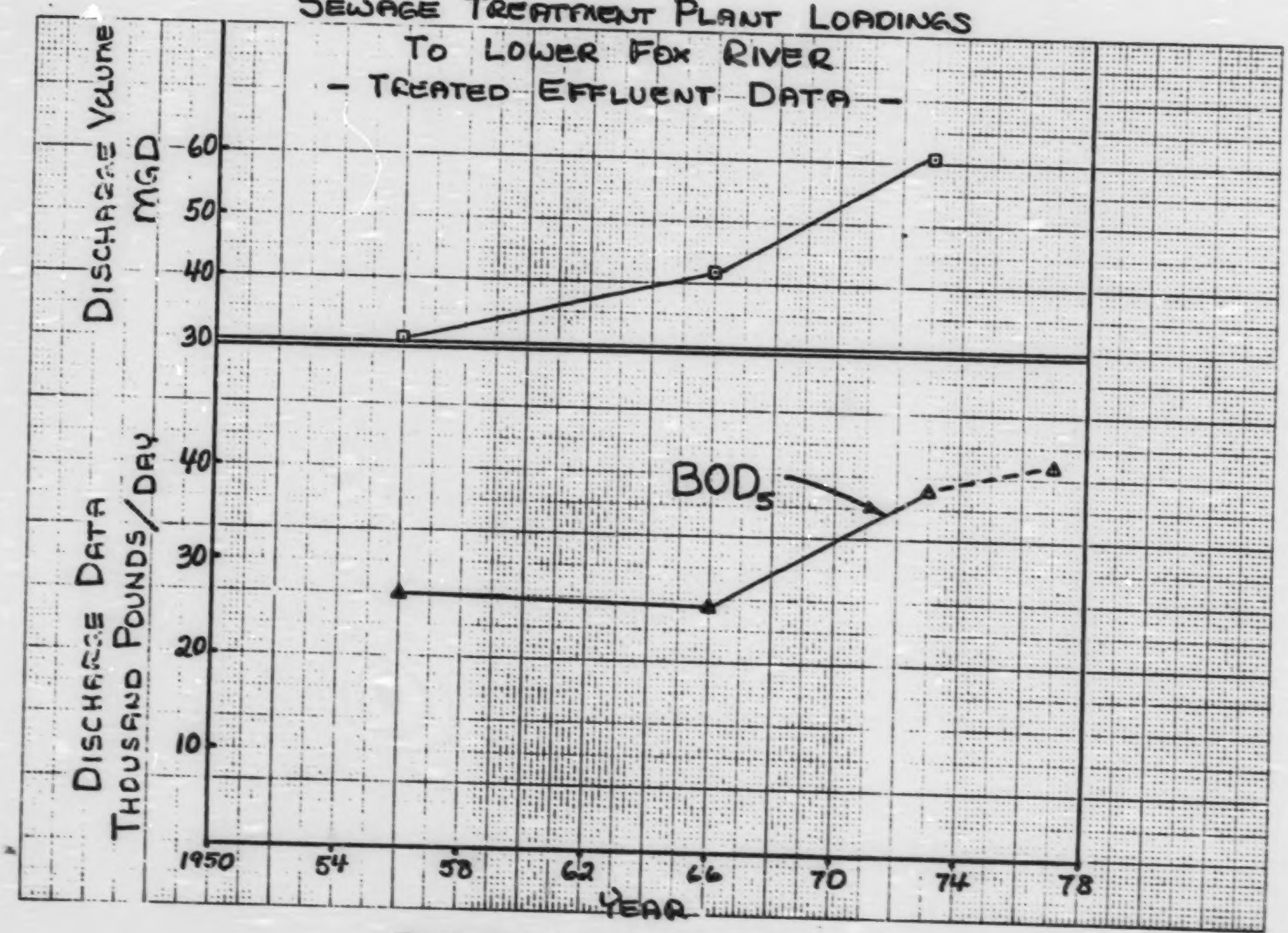
Phosphorus in the form PO_4^{3-} (orthophosphate) appears to be the limiting nutrient for algal emergence in Green Bay. Vanderhoef et al (1972) found that large inputs of soluble phosphate into the Bay preceded active N_2-fixation accompanying blue-green algal blooms. The variations of phosphorus concentrations were closely correlated with fluctuations in the growth of nitrogen-fixing algae.

FIGURE 3.



Projected Figures for 1975 and 1977 are Based
on Proposed EPA Guidelines and are Subject to Revision

FIGURE 4.



The Projected Figure for 1977 is Based
on Proposed EPA Guidelines and is Subject to Revision

TABLE 3.

PULP & PAPER MILL NUTRIENT LOADINGS
TO THE LOWER FOX RIVER, 1971*

COMPANY	KJEL.-N Lb/Day	KJEL.-N Kg/Day	NH_3-N Lb/Day	NH_3-N Kg/Day	NO_3-N Lb/Day	NO_3-N Kg/Day	TOTAL-P Lb/Day	TOTAL-P Kg/Day
American Can Co. (Green Bay)	42	19	------	------	------	------	246	112
Appleton Papers, Inc.	126	57	14	6	12	5	23	10
Bergstrom Paper Co.	480	218	36	16	18	8	176	80
Charmin Paper Co.	7.736	3,508	7,580	3,438	<11	<5	<11	<5
Consolidated Papers, Inc.	1,688	766	2	1	16	8	43	19
Ft. Howard Paper Co.	472	214	115	52	16	8	119	54
Gilbert Paper Co.**	<1.0	<1.0	<0.1	<0.1	<1.0	<1.0	<0.1	<0.1
Green Bay Packaging	32	15	11	5	18	8	7	3
Kimberly-Clark (Badger Globe)**	9	4	<1.0	<1.0	<1.0	<1.0	1	<1
Kimberly-Clark (Kimberly)	350	159	2	1	<1.0	<1.0	321	146
Kimberly-Clark (Neenah)	14	6	<1.0	<1.0	<1.0	<1.0	2	1
Kimberly-Clark (Lakeview)	104	47	<1.0	<1.0	7	3	8	3
Nicolet Paper Co.	1,084	492	253	115	58	26	2	1
Riverside Paper Corp.	58	26	17	8	9	4	5	2
John Strange Div. (Menasha Corp.)	24	11	22	10	30	14	6	3
Thilmany Pulp & Paper (Hammermill Paper Co.)	563	255	------	------	359	163	104	47
George A. Whiting Paper Co.	4	2	<1.0	<1.0	35	16	4	2
TOTAL	12,786	5,799	8,052	3,652	589	268	1,078	488

* All data taken from the W.P.D.E.S. permit application files.

** 1972 data

TABLE 4.

MUNICIPAL SEWAGE TREATMENT PLANT NUTRIENT LOADINGS TO THE LOWER FOX RIVER, 1971*

CITY OR VILLAGE	KJEL.-N Lb/Day	KJEL.-N Kg/Day	NH_3-N Lb/Day	NH_3-N Kg/Day	NO_2+NO_3-N Lb/Day	NO_2+NO_3-N Kg/Day	TOTAL-P Lb/Day	TOTAL-P Kg/Day	PO_4-P Lb/Day	PO_4-P Kg/Day
Appleton	2,210	1,002	703	319	96	44	378	171	284	129
De Pere	1,070	485	436	198	21	10	144	65	128	58
Green Bay Metro.	3,700	1,678	2,730	1,238	150	68	1,083	491	770	349
Kaukauna	561	254	59	27	128	58	81	37	56	25
Kimberly	174	79	114	52	13	6	44	20	32	14
Little Chute	85	38	47	21	13	6	35	16	24	11
Menasha Town S.D. #4 - East Plant	217	98	108	49	26	12	106	48	36	16
Neenah - Menasha Severage Comm.	2,160	980	196	89	146	66	214	97	80	36
Wrightstown	25	11	15	7	4	2	9	4	7	3
TOTAL	10,202	4,625	4,408	2,000	597	272	2,094	949	1,417	641

* Sager, P. E. and J. H. Wiersma, 1972, Nutrient Discharges to Green Bay, Lake Michigan From the Lower Fox River, Proc. 15th Conf. Great Lakes Res.: 132-148. Internat. Assoc. Great Lakes Res.

Phosphorus data was originally reported on a PO_4 basis but has been converted to a P basis in this table.

The findings of Vanderhoef et al (1972, 1973) suggest that phosphorus is the limiting nutrient. Mean soluble phosphate concentrations in 1971 ranged from 3 to 55 ug/l, compared to a range of 35 to 81 ug/l in 1972 for comparable sites from the mouth of the Fox River to Sturgeon Bay. The higher concentrations in 1972 were apparently caused by higher spring runoff of phosphate into Lake Winnebago due to heavy rains before complete ground thaw. Algal growth and C_2H_2-reducing activity were correlated with the higher phosphorus concentrations in 1972. Furthermore, the major bloom in 1972, Aphanizomenon, extended an average of 8 km farther north into the Bay than in the 1971 bloom of Anabaena. The 1971 study concluded that phosphorus was the dominant factor limiting algae growth under the conditions in Green Bay, while the 1972 study concluded that phosphorus or some nutrient input paralleling that of phosphorus was the limiting nutrient for N_2-fixing algae in the lower Bay region.

The Fox River is the major source of phosphorus enrichment of Green Bay. Table 5 (Sridharan and Lee, 1972) shows the input of phosphorus from the five major tributaries. The Fox River is the principal source, contributing approximately 81 percent of the estimated total 4,734,754 lbs. P/year (2,149,578 kg P/year).

Quarterly sampling and analysis for phosphorus conducted over an eight-year period at the mouth of the Fox River by the Wisconsin Department of Natural Resources showed that the range of total soluble phosphate concentration was 0.14 to 0.40 mg P/l with an average of 0.23 mg P/l (Sridharan and Lee, 1972). A study by Allen (1966), involving monthly samplings of lower Green Bay near Little Sturgeon Bay, showed low phosphorus concentrations averaging 0.007 mg P/l for soluble phosphate and 0.033 mg P/l for total phosphate for an eight-month period. Figures 5 and 6 (Wisconsin Department of Natural Resources, 1973) show that the concentrations of total phosphate and orthophosphate decrease as the distance

TABLE 5.

Estimated Phosphorus Input Into Green Bay Through Its Tributaries

River	Flow cfs	Concentration mg P/l	Lbs. P/Yr.
Fox[a]	Average Daily Loading of Total Phosphorus 10,484 Lbs./Day		3,826,660
Oconto[b]	569	0.15	168,264
Peshtigo[b]	825	0.09	146,124
Menominee[b]	3,096	0.08	487,434
Escanaba[b]	900	0.06	106,272
	Total - Lbs. P/Yr.		4,734,754

1 cfs = 0.02832 m^3
1 lb. = .4536 Kg

[a] Sager (1971)

[b] U.S. Dept. of Interior, Federal Water Control Administration (1966)

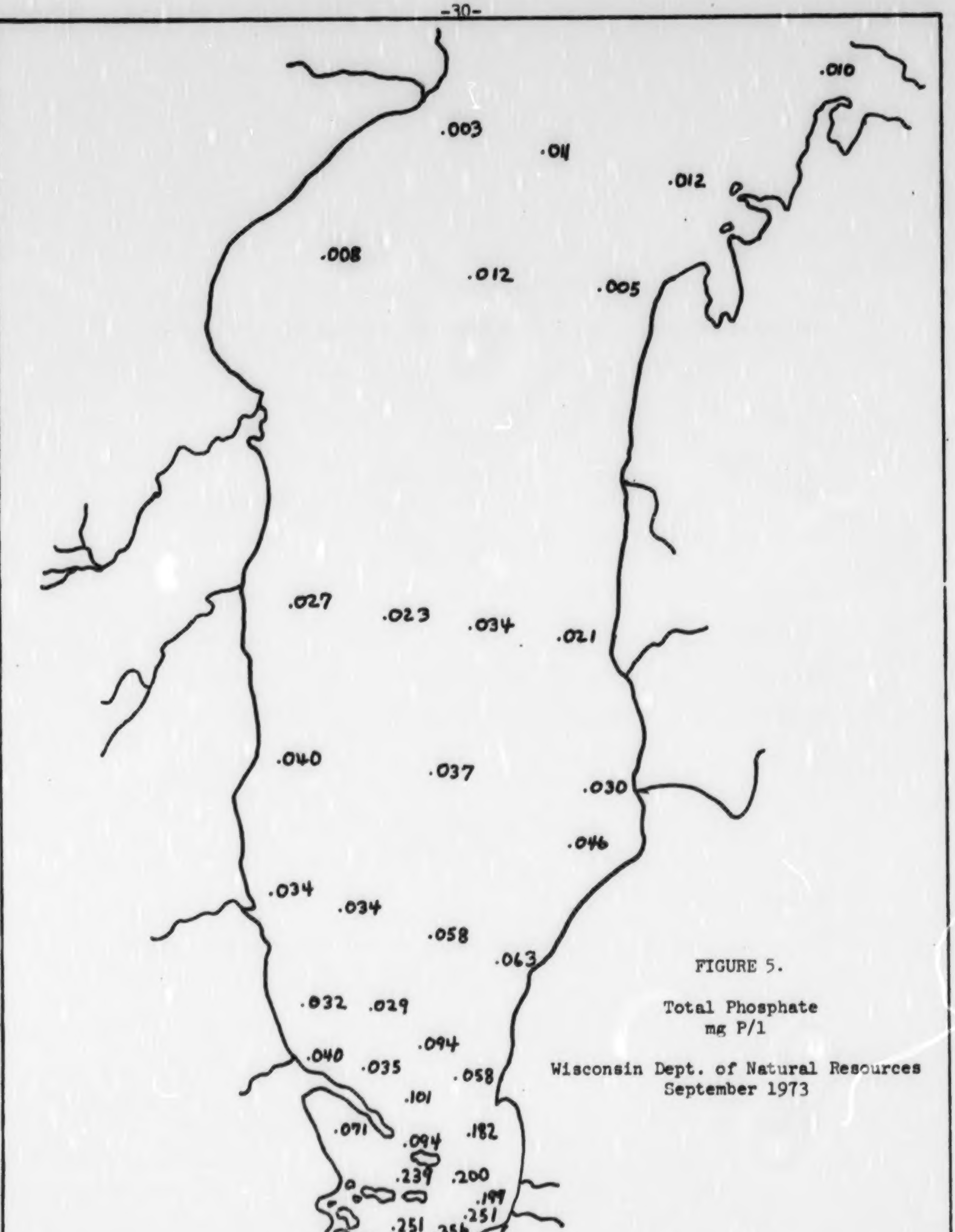


FIGURE 5.

Total Phosphate
mg P/l

Wisconsin Dept. of Natural Resources
September 1973

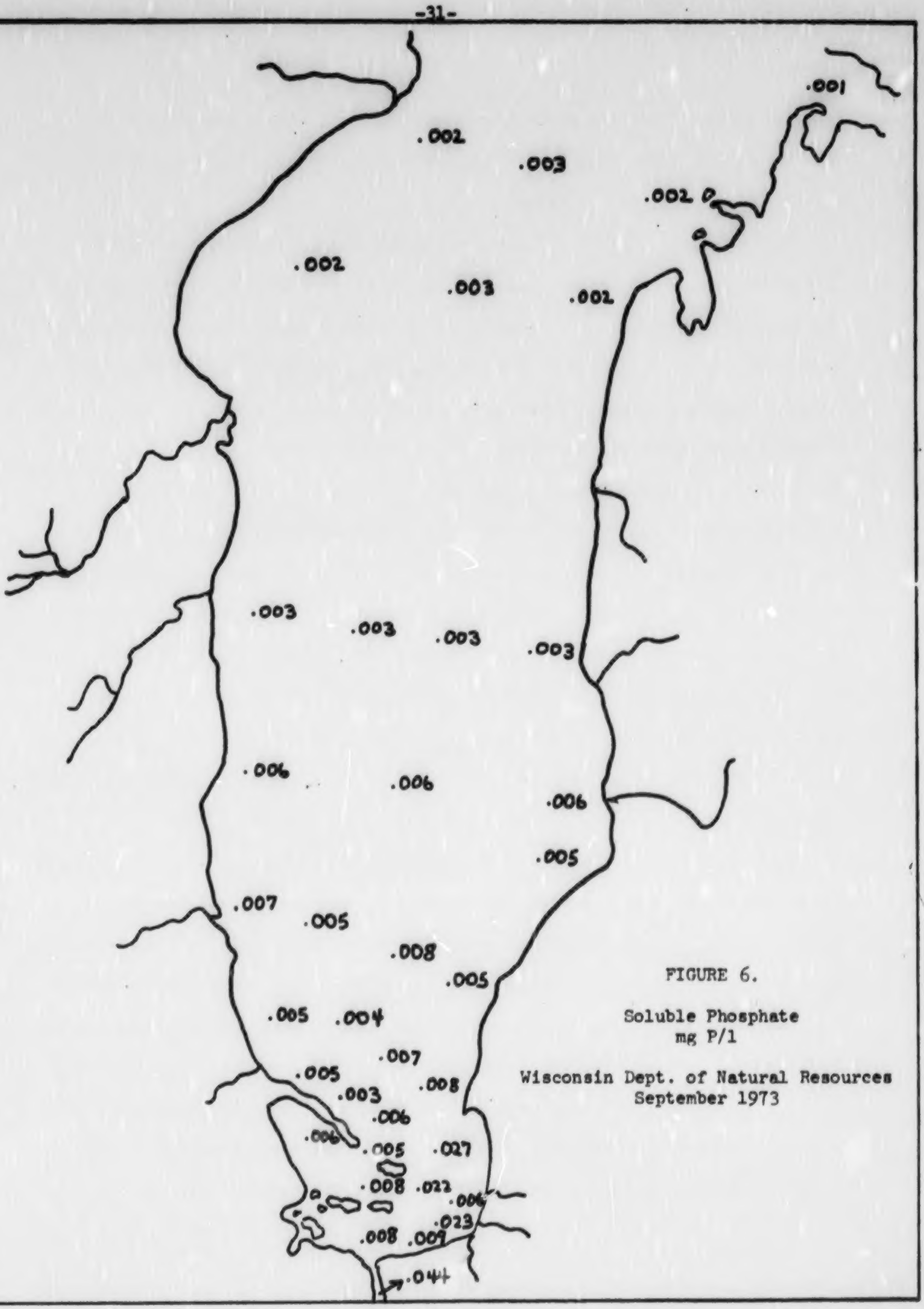


FIGURE 6.

Soluble Phosphate
mg P/l

Wisconsin Dept. of Natural Resources
September 1973

from the mouth of the Fox River increases. These findings are consistent with results of other studies and justify considering the Fox River as the major source of phosphorus input.

Approximately two-thirds of the total phosphorus discharged by the Fox-Wolf River is contributed by municipal and industrial wastes. (For estimated source input, see Table 6). According to Wiersma et al (1973), the Lower Fox River drains only 7 percent of the total drainage basin of the Fox-Wolf River system. The most severe deterioration of water quality occurs in this section. A concentrated municipal-industrial complex makes intensive use of the river for disposal and assimilation of wastes.

Sager and Wiersma (1972) established a biweekly monitoring program for municipal treatments to assess the nutrient input to the Lower Fox River from October, 1970 to September, 1971. Annual loadings of orthophosphate and total phosphorus (both as P) averaged 1,417 lb/day (641 kg/day) and 2,094 lb/day (949 kg/day), respectively. The Green Bay Metropolitan Plant contributes approximately 50 percent of these totals. This amount is very significant for Green Bay since the plant is located 0.5 km from the mouth of the river and essentially discharges its effluent directly to Bay waters.

While nutrient-rich wastes from the sewage treatment and industrial plants on the Lower Fox River are very important, the water quality of the river is already reduced by Lake Winnebago water. This hypereutrophic lake contributes waters with high algae and nutrient concentrations, especially phosphorus, to the Lower Fox River. Sager and Wiersma (1972) considered Lake Winnebago to be a significant influence on the water quality of the river and lower Green Bay. The average annual loadings from Lake Winnebago for total phosphorus as PO_4^{3-} is 6,620 lb/day (3,012 kg/day) and almost equals the total phosphorus for the sewage treatment plants (see Table 7). Seasonal fluctuations of nutrient

TABLE 6.

Estimated Phosphorus Sources for the Fox-Wolf River*

Source	Annual Contribution (Lbs. P)	Percent Estimate
Municipal and Industrial Wastewater	1,515,000	62.5
Urban Runoff	95,800	3.5
Rural Runoff	822,000	33.5
Precipitation on Lake-River Surfaces	12,700	0.5
Groundwater	-	-
Total	2,445,500 lbs. P/yr. (1 lb. = .4536 Kg)	100

*Sridharan and Lee (1972)

TABLE 7. Average loadings on the Fox River from Lake Winnebago. Values in lbs./day.

	Average Flow (ft^3/sec)^2	Ortho PO_4	Total P as PO_4	NO_3-N	NH_3-N	COD	Suspended Solids
June-August	2,330	786	7,730	1,280	1,890	403,000	216,000
September-November	3,220	3,520	5,800	5,650	5,800	399,000	197,000
December-February	4,010	1,680	4,100	8,620	4,100	454,000	65,200
March-May	6,600	2,290	8,830	24,200	8,800	916,000	436,000
Annual Average	4,040	2,070	6,620	9,940	5,200	543,000	229,000

Multiply by 0.4536 to convert loadings to kg/day.
Multiply ft^3/sec by 0.02832 to convert flow to m^3/sec.

Sager and Wiersma (1972)

loadings to Green Bay are closely correlated, not only with changes in Fox River flow, but also with variations in the water quality of Lake Winnebago.

Runoff from rural agricultural land and urban areas are believed to be a substantial source of phosphorus input to Green Bay. A study conducted by the U.S. Department of Health, Education and Welfare (Hall, 1966) found that the amount of phosphate reaching streams from land runoff in the Green Bay area was about 1,167,000 pounds (531,000 kg) of phosphorus per year. Table 5 shows estimated phosphorus input from rural runoff and urban runoff to the Fox-Wolf River system to be 822,000 lbs./year (37,400 kg/year), 33.5 percent and 95,800 lbs./year (43,600 kg/year), 3.5 percent, respectively. In conclusion, phosphorus contributed by surface runoff from nonpoint sources is a significant and measureable source.

Sager and Wiersma (1972) noted that, during the spring (March-May), loadings of nutrients were the highest. The levels were more than could be accounted for by Lake Winnebago and municipal treatment plants. Surface runoff from the drainage basin partially contributed to this excess. Sager (1971) found that extremely high concentrations of soluble phosphate in the inner Bay were correlated with heavy precipitation and a subsequent increase of phosphorus in the river. The heavy precipitation caused runoff which produced loadings to the municipal treatment plants in excess of capacity. In addition, the incomplete separation of storm and sanitary sewers contributes to inefficient phosphorus removal. Only within the past few years have the cities of Green Bay, Neenah and Menasha separated their sewage systems.

Sridharan and Lee (1972) indicate that sediments in the Fox River and Green Bay were potentially a significant source of phosphorus. Sediments contained large amounts of phosphorus and demonstrated releasability to overlying waters under laboratory conditions. Rates of release ranged from 3×10^{-6} to 3.4×10^{-4} mg P/g sed/hr for oxic conditions and a high rate of release

3.2×10^{-5} to 8×10^{-3} mg P/g sed/hr for anoxic conditions. Sediments contained levels of phosphorus up to 2,000 ppm. Although these findings were under laboratory conditions, the relatively shallow, highly turbulent nature of the lower Bay region should at times approach the well-mixed conditions occurring in the laboratory and produce optimum conditions for release.

The rate of release of phosphorus from sediments was found to be dependent on several factors (Sridharan and Lee, 1972). Proximity of stations to the mouth of the Fox River was associated with both higher release rates and amounts of release. Orthophosphate and total phosphate concentrations in sediments and water of stations 4 and 5a located at or near the mouth of the Fox River showed the highest rates of release (Table 8, Figure 7). Station 11 had the lowest rate of release. The amount of phosphorus released was the highest at station 5a and decreased at stations 5, 9 and 11 with increasing distance from the mouth. Phosphorus release was directly affected by the nature of the sediment. Regions of low percent solids were associated with high orthophosphate release. Station 11 contained more sand size particles (high percent solids) than the other locations in lower Green Bay. Station 11 has a poor release of orthophosphate when compared to station 5a which is high in silt-like particles, low in percent solids. Furthermore, it was found that high iron concentrations were associated with high orthophosphate release. Station 5a was found to have a high iron concentration. Since iron has been associated with anoxic phosphorus release, and higher concentrations of iron were found in the leaching solution of 5a than in 5, then a higher orthophosphate release from station 5a is predictable.

Jayne and Lee (1971) sought to model phosphate transport between the sediment and water. They defined a distinct region extending about 3 km from the mouth of the Fox River that was nearly cut off from the Bay by a peninsula and sandbar. This region served as a source of phosphate for the overlying waters during the summer months. The sediment here accounted for 20 to 30

TABLE 8. Rates of Phosphorus Release for Green Bay Sediments

Station Number	Percent Solids %	Phosphorus mg/g	Net Sediment Used g	Rates of Release		
				mg P/1/Day	mg P/g sed/hr	mg P/g sed P/hr
			O X I C			
5	30	0.69	50	4.3×10^{-3}	2.4×10^{-4}	0.342
5a	29	1.10	50	6.0×10^{-3}	5.4×10^{-4}	0.312
11	65	0.17	50	2.5×10^{-4}	3.0×10^{-6}	0.018
5a Core (0-5 cm)	18	1.00	50	6.0×10^{-3}	3.4×10^{-4}	0.312
5a Core (35-40 cm)	65	0.35	50	7.4×10^{-4}	1.9×10^{-5}	0.054
9	20	1.62	25	1.9×10^{-2}	7.6×10^{-4}	0.190
9	20	1.62	50	3.8×10^{-3}	3.1×10^{-4}	0.190
9	20	1.62	100	7.1×10^{-3}	2.9×10^{-4}	0.180
9	20	1.62	200	4.2×10^{-3}	8.8×10^{-5}	0.050
4	38	1.50	200	2.5×10^{-3}	3.4×10^{-5}	0.020
			A N O X I C			
5	30	0.69	50	1.0×10^{-1}	6.0×10^{-3}	8.50
5a	29	1.10	50	1.4×10^{-1}	7.8×10^{-3}	7.1
11	65	0.17	50	2.6×10^{-3}	3.3×10^{-5}	0.192

Stations 5, 5a, 5a Core, 11 and 4 were sampled on October 6 1969 and Station 9 was sampled on October 28, 1968.

Sridharan and Lee (1972)

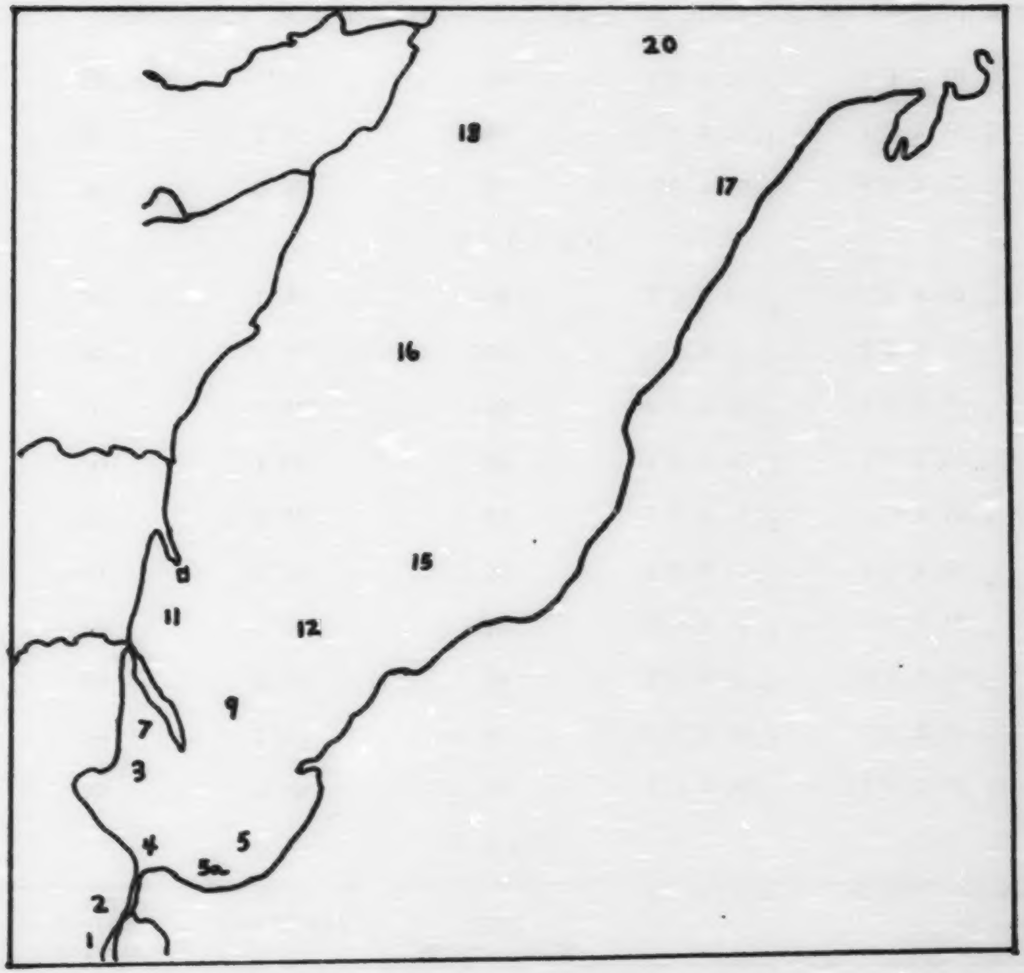


FIGURE 7. Sampling Stations for Green Bay.

Sridharan and Lee, 1972

percent of the phosphorus transported out of this constricted area during summer. Beyond this region, phosphate was absorbed by the sediments during the period May through November, for which data were collected. Jayne and Lee were unable to predict phosphate transport due to insufficient hydrodynamic information.

Sager and Wiersma (1972) found that the sediments along the Lower Fox River could partially account for the seasonal fluctuations in phosphorus loadings to the Bay. Assimilation and sedimentation apparently explained the decrease in concentrations of orthophosphate during summer and fall. During winter and spring, the downstream concentrations showed an increase. This increase was believed to be due to reduced assimilation of orthophosphate caused by colder temperatures and an increase in release of orthophosphate from bottom sediments generated by increased flow rates creating greater disturbances and sediment suspension.

Levels of phosphorus in the Bay can be used to describe the dispersal and distribution of Fox River water and can give insight to eutrophication processes which occur. However, when considering levels in certain areas or trends in levels, precautions must be taken. Beeton (1969) found that published data on increases in nutrients or eutrophication for the past 90 years were generally inadequate for evaluating trends. No trend in phosphorus levels was found due to insufficient and conflicting data. The data was obscured by analytical differences, too few samples combined with unrepresentative coverage, and conflicting results.

Studies which determined phosphorus levels for Green Bay yielded results similar to those of Ahrnsbrak and R. A. Ragotzkie (1970) with regard to the dispersal of Fox River water and mixing of Bay waters. Sager and Wiersma (1972) found that total phosphorus and orthophosphorus concentration gradients were steeper inside of Long Tail Point than at the outer points (Fig. 8, 9). This agrees with Ahrnsbrak and Ragotzkie (1970) who found the greatest change in percent composition of river and Bay water, a decrease of about 30 percent by volume, in this same area. Total phosphorus gradients reflect dilution and dispersal patterns better than orthophosphorus gradients. Sager and Wiersma felt that this dilution is caused by processes of absorption, sedimentation, biological uptake and release being involved with the dynamics of orthophosphate distribution.

Rousar and Beeton (1973) also found a steep concentration gradient from the mouth of the Fox River to station 10, 16 km out (Fig. 10). This gradient was a result of dilution of polluted Fox River discharge by Bay water. North of station 10, no clear patterns of mixing of Bay and Fox River water were apparent. Values of phosphorus concentrations for all samples ranged from 30.5 to 430 ug P/liter and averaged 87.8. Excluding the three stations closest to the mouth of the Fox River, the average was 47.7 ug P/liter.

Sager (1971), by studying phytoplankton concentrations, was able to define two discrete water masses in lower Green Bay. One mass was characteristic of Fox River parameters and the other was representative of Bay water. The diffuse interface between the two water masses was located approximately 8 km from the mouth of the Fox in the vicinity of Long Tail Point. The extreme lower Bay was dominated by river species which exhibited high biomass and low uptake of luxury phosphorus in the presence of high available phosphorus. The Bay area water consisted of low biomass and high luxury uptake of orthophosphate in the presence of low concentrations of available phosphorus.

In addition to large variations in levels of phosphorus as one proceeds out into the Bay, variations in phosphorus levels have also been detected between the eastern and western half of the lower Bay area. The eastern portion generally

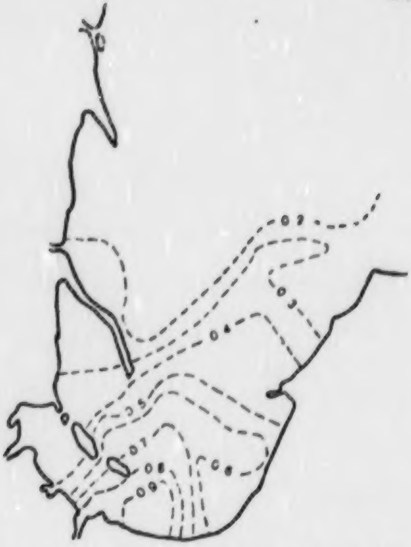


FIG. 8. Total phosphate isopleths (mg/l) in lower Green Bay (20 July 1971).

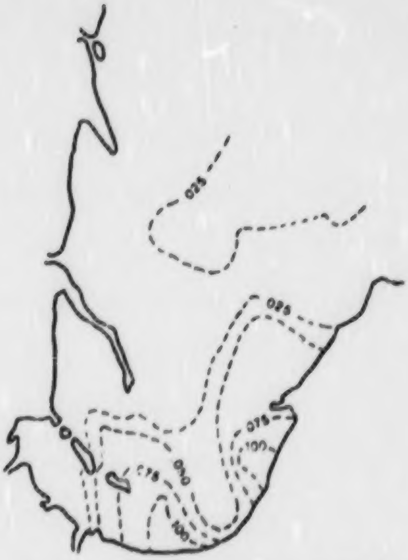


FIG. 9. Orthophosphate isopleths (mg/l) in lower Green Bay (20 July 1971).

Sager and Wiersma (1972)

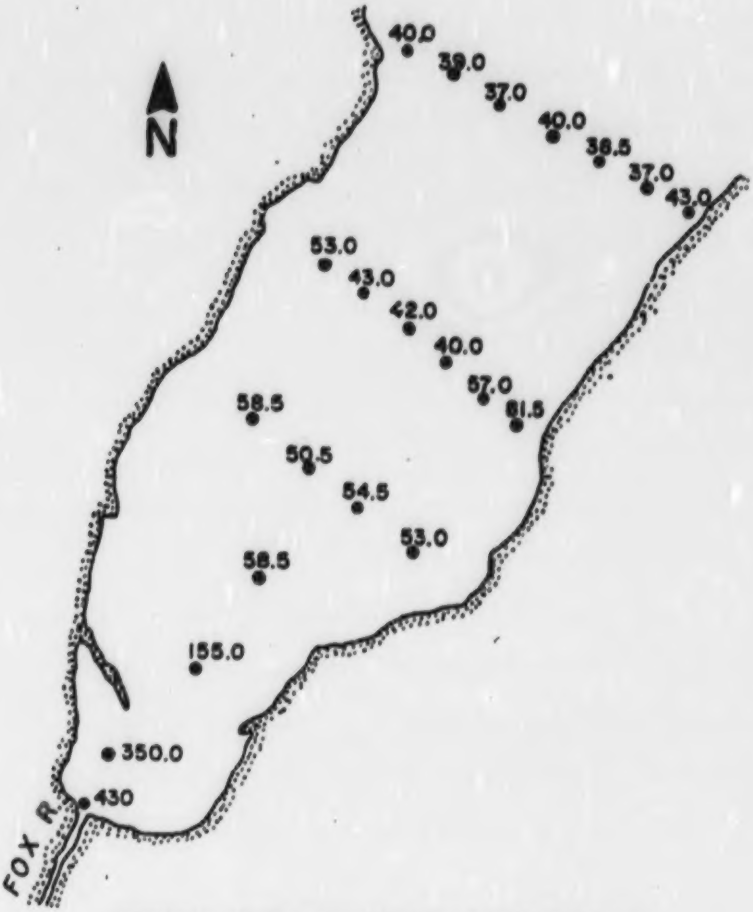


FIGURE 10. Surface concentrations of total phosphorus in µg P/liter from 2 m depth.

Rousar and Beeton (1973)

demonstrates higher concentrations of orthophosphate than the western. The highest concentrations appear in the southeast corner of the Bay (Fig. 9). Sager and Wiersma (1972) suggest that these results reflect the dispersal of Fox River water moving out and along the eastern shore. Lower westerly values may also be attributed to the influence of nutrient assimilation by the predominant marshy character of the shoreline.

The southeast corner contains higher concentrations of orthophosphate than exist at the mouth of the Fox River. This appears to reflect regeneration activity. Sager and Wiersma (1972) could not determine whether this regeneration activity originated from bottom sediments or suspended organic material or both. Total phosphate concentrations were also high in this area, indicating a possible local concentration of organic matter or algae in suspension. Massive algal growths as high as 90 mg chlorophyll a/m^3 (Sager, 1971) and high concentrations of phosphorus with high release capabilities (3.4×10^{-4}/g sed/hr Sridharan and Lee, 1972) in this area could supply sufficient substrates for the release of orthophosphate from decomposition or other chemical activity.

As mentioned earlier in this report, phosphorus loadings to the Bay are subject to seasonal variations. Knowledge of these fluctuations is essential for the assessment of the importance of the various sources of phosphorus input and for the demonstration of processes of assimilation and release of phosphate in the river system.

Sager and Wiersma (1972) have monitored variations in total phosphate and orthophosphate concentrations for ten stations (Figure 11) from Lake Winnebago to the mouth of the Fox River. Seasonal variations in phosphorus input were related to the quality of Lake Winnebago discharges and to the processes of assimilation, sedimentation and release in the river. The effect

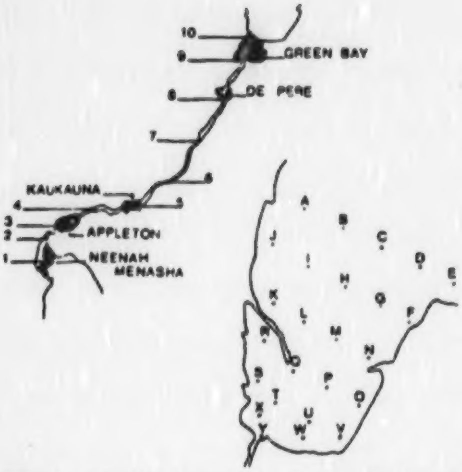


FIG. 11. Sampling stations on the Fox River (1-10) between Lake Winnebago and Green Bay and on lower Green Bay (A-Y). The Harbor Entrance Light (station C) is 9.5 mi. (15.3 km) from the mouth of the river.

Sager and Wiersma (1972)

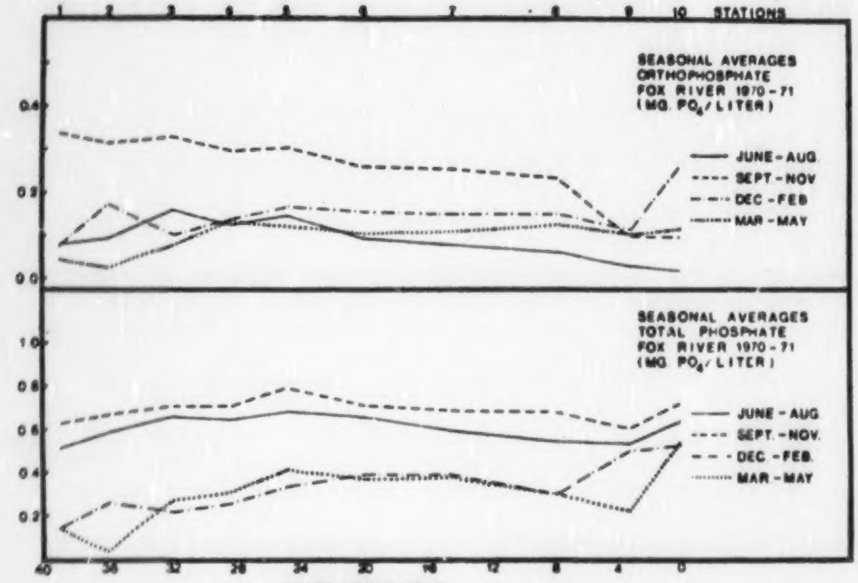


FIG 12. Seasonal averages of orthophosphate and total phosphate concentrations in the Fox River. Averages based on weekly samples, July to September 1970 and biweekly samples thereafter to October 1971.

Sager and Wiersma (1972)

of these variables with respect to phosphorus varied with seasonal conditions. Figure 12 shows seasonal averages of orthophosphate and total phosphate concentrations during the period July, 1970 to October, 1971. The following is a discussion of their findings.

During the fall period, the effect of phosphorus release from Lake Winnebago following the summer growth of algae is evident from the observed high concentrations at station I. Algal abundance during fall is at a substantially lower level than the summer period, approximately 44 mg/m^3 to 77 mg/m^3 chlorophyll a, respectively. Orthophosphate concentrations decrease as one moves downstream in both summer and fall. This reflects chemical assimilation and sedimentation by the river system. Quiescent waters behind the numerous dams are possible sites for deposition of phosphate associated with algae, organic matter and inorganic matter. Concentrations decrease downstream despite an input of approximately 4,400 lbs./day (2,000 kg/day) of orthophosphate from the eleven sewage treatment plants along the river.

The response of the river during winter and spring to the additional loadings by municipal treatment plants is different from that in summer and fall. During this period, the average concentrations of orthophosphate is lower throughout the river. However, concentrations increase as one moves downstream. The downstream increase can be attributed to colder water temperatures which cause reduced assimilation capabilities by the sediments and an increase in the release or regeneration of phosphorus from bottom sediments, suspended solids, plant materials, etc. This is aided in the spring by runoff from agricultural lands, and higher turbulent flows acting to resuspend the bottom materials. The lower overall concentrations of orthophosphate during winter and spring is apparently due to increased flow rates (greater volume) and decreased phosphorus loadings from Lake Winnebago.

Data for total phosphorus demonstrates the same downstream trend of increasing concentrations for winter and spring. It appears that the same factors (low rates of assimilation, municipal loadings and release from the river, especially with increased flow rates) account for this pattern as they did for the orthophosphate pattern. Summer and fall concentrations of total phosphorus in the river are high and reflect a combination of low flow rates and excessive algal growths of Lake Winnebago and the Fox River.

Summer concentrations of total phosphorus in the Fox River were lower than the fall concentrations despite algae densities which were highest in summer. The high orthophosphate concentrations found in the fall period could be responsible for the higher total phosphorus values. The high orthophosphate concentrations for fall, 61 percent of the total phosphorus, was apparently due to decomposing organic matter.

In summary, Lake Winnebago contributes phosphorus compounds to the lower Fox River in excess of or approximately equal to that contributed by municipal treatment plants. Seasonal variations of phosphorus loadings to Green Bay from the Fox River can be explained in part by seasonal changes in assimilation and release in the river and Lake Winnebago. Spring loadings to the Bay are highest among the seasons and usually represent levels greater than that which can be attributed to Lake Winnebago and municipal treatment plants. Sources of this increase could be surface runoff from the drainage basin and release from the river system.

Nitrogen Loadings

Nitrogen is added to Green Bay in substantial quantities as the result of loadings by the Fox River. Sager and Wiersma (1972) have found the annual average loadings at the mouth of the Fox River to be 17,100 lbs./day (7,800 kg/day) for nitrate-nitrogen (NO_3-N) and 12,400 lbs./day (5,600 kg/day) for ammonia-nitrogen (NH_3-N).

Two major sources of nitrogen to the Fox River are loadings from Lake Winnebago and from municipal treatment plants. Tables 6 and 7 give average loadings from these sources. The average annual loadings from Lake Winnebago are 9,940 lbs./day (4,500 kg/day) and 5,200 lbs./day (2,400 kg/day) for NO_3-N and NH_3-N, respectively. Comparable loadings from municipal treatment plants are 597 lbs./day (273 kg/day) and 4,408 lbs./day (2,000 kg/day), respectively. These values indicate that Lake Winnebago is the most significant source of nitrogen based on a yearly period. However, when considering loading levels for seasonal periods, it is found that municipal treatment plants are the most significant sources in summer and account for almost 75 percent of the loadings to the Bay (Sager and Wiersma, 1972).

Nitrogen loadings from the Fox River are subject to seasonal fluctuations. Table 9 shows seasonal average loadings to Green Bay from the Fox River at station 10 which is located near the mouth of the river. There is a large difference between the highest loading period, March-May, and the lowest loading period, June-August. These fluctuations are caused by several interacting factors; biological decomposition, concentrations of dissolved oxygen, concentrations of algae, surface runoff in the drainage basin, flow rates and assimilation by the river system. The following is a summary of seasonal variations in concentrations and loadings of nitrogen complexes based on the findings of Sager and Wiersma (1972).

Levels of NH_3-N were closely correlated with dissolved oxygen (DO) levels in the Fox River. Figure 13 presents data for seasonal averages of DO and NH_3-N concentrations in the Fox River. The most significant seasonal change in DO level was in the summer and fall months when average concentrations decreased in the middle section of the Fox River. This seasonal DO sag was caused by high organic loadings in this portion of the Fox River and high decomposition rates characteristic of warm temperatures in summer and fall. Furthermore, the lower flow rates encountered in summer and early fall also contribute to depressed

TABLE 9. Average loadings to Green Bay from the Fox River at Station 10. Values in lbs./day.

	Average Flow (cfs)^2	Ortho PO_4	Total P as PO_4	NO_3-N	NH_3-N	COD	Suspended Solids
June-August	2,330	363	7,670	563	6,480	761,000	232,000
September-November	3,220	1,730	8,580	3,200	7,100	689,000	226,000
December-February	4,010	5,190	7,120	5,080	10,600	1,045,000	187,000
March-May	6,600	5,040	29,500	59,600	25,600	1,648,000	1,270,000
Annual Average	4,040	3,080	13,200	17,100	12,400	1,036,000	479,000

Multiply by 0.4536 to convert loadings to kg/day.
Multiply ft^3/sec by 0.02832 to convert flow to m^3/sec.

Sager and Wiersma (1972)

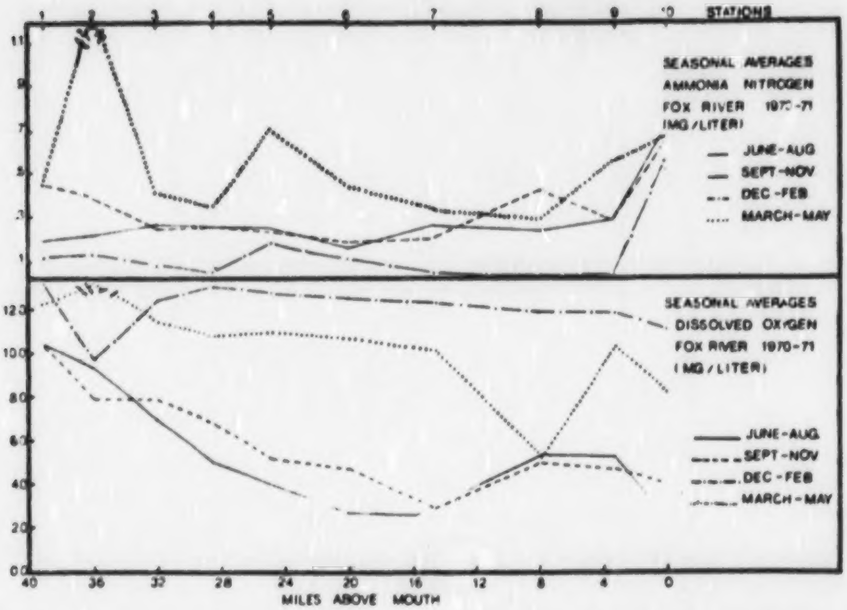


FIG 13. Seasonal averages of dissolved oxygen and ammonia-nitrogen concentrations in the Fox River. Average values based on weekly samples, July to September 1970 and bi-weekly samples thereafter to October 1971.

Sager and Wiersma (1972)

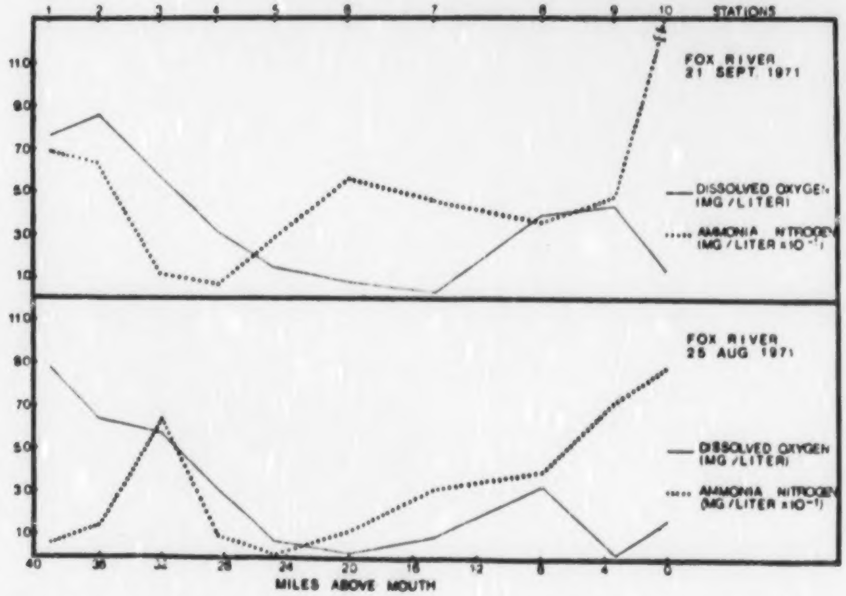


FIG. 14. Changes in ammonia-nitrogen concentrations in relation to dissolved oxygen deficits in the Fox River.

Sager and Wiersma (1972)

oxygen levels. Beyond the midsection of the river, DO concentrations begin to recover as a result of decreased BOD loadings. However, at the mouth of the Fox River, increased organic loading from the De Pere-Green Bay area again results in depressed DO content. The low dissolved oxygen values and increased rates of decomposition during the summer and fall are reflected in the gradual increase of NH_3-N concentrations downstream. Summer NH_3-N concentrations were the highest. In contrast, NH_3-N concentrations were lowest in winter and reflected high DO concentrations and low rates of organic decomposition associated with winter conditions.

The midsection and the mouth of the Fox River were highly significant in producing increased levels of NH_3-N. Both areas demonstrated severe oxygen deficits and a release to the Fox River and Bay of NH_3-N as a by-product of organic decomposition. The high value of NH_3-N at the mouth of the Fox River in summer corresponds to decreased loadings of NO_3-N and reflects a possible chemical reduction process in this oxygen deficient area. Figure 14 represents data from two sampling dates in summer and early fall of 1971 and illustrates the relationship of DO deficiencies and increased concentrations of NH_3-N.

Nitrogen in water discharged from Lake Winnebago is predominately associated with organic matter. Loadings of NO_3-N and NH_3-N were lowest during summer months when algae were utilizing and assimilating these nitrogen complexes. During the summer and fall, chlorophyll _a_ concentrations produced by high densities of phytoplankton ranged from 40 to 180 ug/l. It appears that the decomposition of this algae and organic matter in the fall and winter resulted in increased loadings of NO_3-N and NH_3-N in the Fox River. Nitrate and ammonia forms contribute between 14 percent and 19 percent of the total nitrogen loadings at this time. However, during spring, greater loadings of inorganic nitrogen leave Lake Winnebago, partially due to increased flows (Table 7).

Ammonia-nitrogen loadings to the Bay were lowest in summer, 6,480 lbs./day (2,900 kg/day), and highest in spring, 25,600 lbs./day (11,600 kg/day). These increases during spring were apparently the result of surface runoff in the drainage basin and increased flow rates. Spring loadings are also affected by assimilation processes along the course of the Fox River. It appears that NO_3-N is assimilated in the Fox River between Lake Winnebago and the mouth of the river throughout the year, but only during spring do the NO_3-N loadings increase at the mouth of the Fox River. NH_3-N is assimilated in the river during the summer months.

Nitrogen fixation by organisms can be a significant nonpoint source of nitrogen input to the Green Bay system. Nitrogen fixation resulting from algal blooms contributes substantially to the Bay's combined nitrogen and intensifies eutrophication. Vanderhoef et al (1972, 1973) have investigated this source of nitrogen input by using acetylene reduction as an index of nitrogen fixation. During the peak week of Anabaena bloom (June 12 to June 19, 1972), 94,000 kg of fixed nitrogen were added to the surface 2 meters of water in the lower 400 km^2 of the Bay by N_2-fixing algae. Throughout the summer, the average rate of C_2H_2 reduction at the two highest nitrogen fixation sampling sites was greater than 50 moles per liter per hour. In a region constituting a major portion of the lower Bay, it was estimated that 2.9×10^5 kg of NH_4^+-N was produced by nitrogen fixation between June 14 and August 17, 1972. For the same period, 7.5×10^5 kg $(NH_4^+ + NO_3^-)$-N was discharged to the Bay by the Fox River.

A limited amount of historical data exists for nitrogen concentrations in Green Bay. Therefore, it is difficult to assess changes in levels over the years. However, it may be reasonable to obtain information about Green Bay by making correlations with trends found for Lake Michigan.

Beeton (1969) has documented environmental changes for Lake Michigan. Figure 15 shows nitrogen data from the Milwaukee water plant. Organic nitrogen (albuminoid ammonia) has increased and inorganic nitrogen (nitrate) has decreased over a 38-year period. Inorganic nitrogen is apparently converted by plankton to organic nitrogen resulting in the albuminoid ammonia increase. Surveys of several areas of Lake Michigan by the U.S. Public Health Service (1962, 1963) suggest that this conversion continues to be significant in parts of Lake Michigan. Nitrate concentrations were 0.12 ppm in the southern part of Lake Michigan and 0.19 ppm in the central part. The lower nitrate values in the southern portion were attributed to the uptake of inorganic nitrogen by plankton which were more numerous in this region (Risley, Fuller, 1965). Allen (1966) found that nitrates were much lower in the highly productive waters of Green Bay than in Lake Michigan. In fact, nitrate concentrations were so low in September of 1965 that it was not measureable. Allen's data confirms the conclusion that Green Bay, especially the lower Bay, is more advanced in terms of eutrophication than Lake Michigan.

Schraufnagel et al (1968) investigated pollution in the Lower Fox River and Green Bay during 1966 and 1967. Table 10 is a summary of the nutrient data collected. Concentrations are expressed as mg/l. No conclusions can be made for the region inside of the 10-mile (16 km) light since only two nutrient samples were collected and the results are inconsistent. The summer samples collected beyond the light generally revealed less than .3 mg/l total inorganic nitrogen (sum of ammonia, nitrite, and nitrate nitrogen). The data suggests that the concentrations of nitrogen beyond 10 miles (16 km) are marginal for blooms of planktonic algae. Algae blooms were generally confined to the inner Bay area and observed only occasionally between 16 km and 48 km from the mouth. No algal blooms were found beyond 64 km. The nitrogen data are moderately consistent with the algae observations.

TABLE 10.

NUTRIENT CONCENTRATIONS FROM GREEN BAY COLLECTION (1966)

Date	Miles from Mouth of Fox	Nitrogen as					Phosphorus as		Color (s.u.)
		T.O.	NH_3	NO_2	NO_3	TION	Sol.P	Tot.P	
10-19-66S	1	1.57	.46	.007	.2	(.667)	.009	.150	50
8-11-66S	4	.45	.11	.004	.08	(.194)	.024	.032	
8-09-66S	10	.83	.12	.003	.08	(.203)	.012	.088	20
8-09-66B	10	1.01	.07	.004	.08	(.154)	.015	.122	22
10-19-66S	10	.39	.05	.002	.06	(.112)	.01	.06	9
8-09-66S	20	.38	.04	.002	.06	(.102)	.004	.058	
8-09-66S	20	.62	.09	.003	.04	(.133)	.012	.066	8
10-19-66B	20	.63	.11	.002	.04	(.152)	.012	.064	7
8-10-66S	30	.50	.06	.002	.04	(.102)	.007	.074	8
8-10-66B	30	.42	.09	.002	.18	(.272)	.014	.06	8
10-19-66S	30	.36	.04	.008	.06	(.108)	.009	.064	
8-18-66S	40	.39	.08	.005	.04	(.125)	.011	.048	8
8-18-66B	40	.26	.08	.002	.20	(.282)	.014	.038	5
10-21-66S	40	.29	.10	.01	.14	(.250)	.009	.052	
8-19-66S	60	.25	.02	.004	.05	(.074)	.018	.028	
10-21-66S	60	.11	.09	.004	.14	(.234)	.016	.03	6
8-19-66S	70	.26	.08	.004	.10	(.184)	.01	.02	
8-19-66B	70	.24	.05	.008	.30	(.358)	.01	.024	
10-21-66S	70	.14	.03	.003	.24	(.273)	.014	.044	
5-18-66S	Michigan	.19	.02	.003	.14	(.163)	.014	.016	
8-18-66B	Michigan	.22	.05	.003	.20	(.253)	.008	.022	
10-21-66S	Michigan	.13	.04	.002	.24	(.282)	.016	.032	

Schraufnagel, et al (1968)

Chlorophyll a, ammonia and organic nitrogen concentrations obtained by the Wisconsin Department of Natural Resources in September, 1973 are presented in Figures 16, 17 and 18. In general, areas which demonstrated high chlorophyll a concentrations, indicating high algal concentrations, had the highest values of organic nitrogen and ammonia nitrogen.

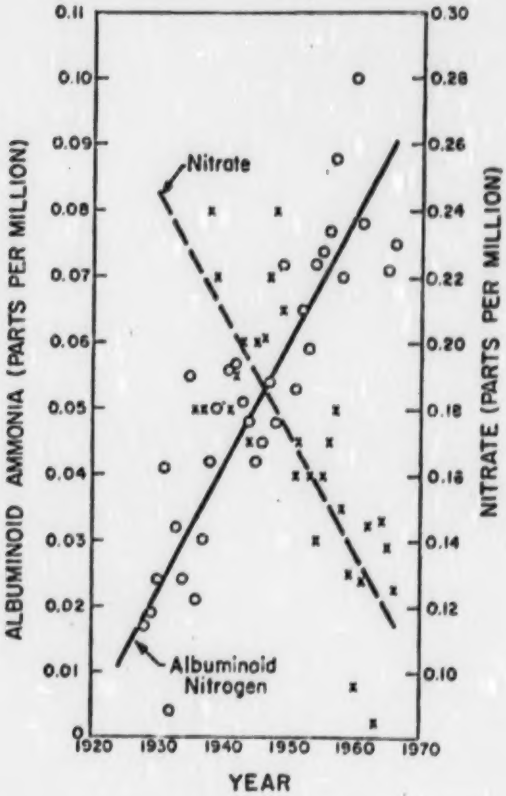


FIGURE 15 Changes in nitrate-N (x) and albuminoid ammonia (O) at the Milwaukee, Wisconsin, intake in Lake Michigan.

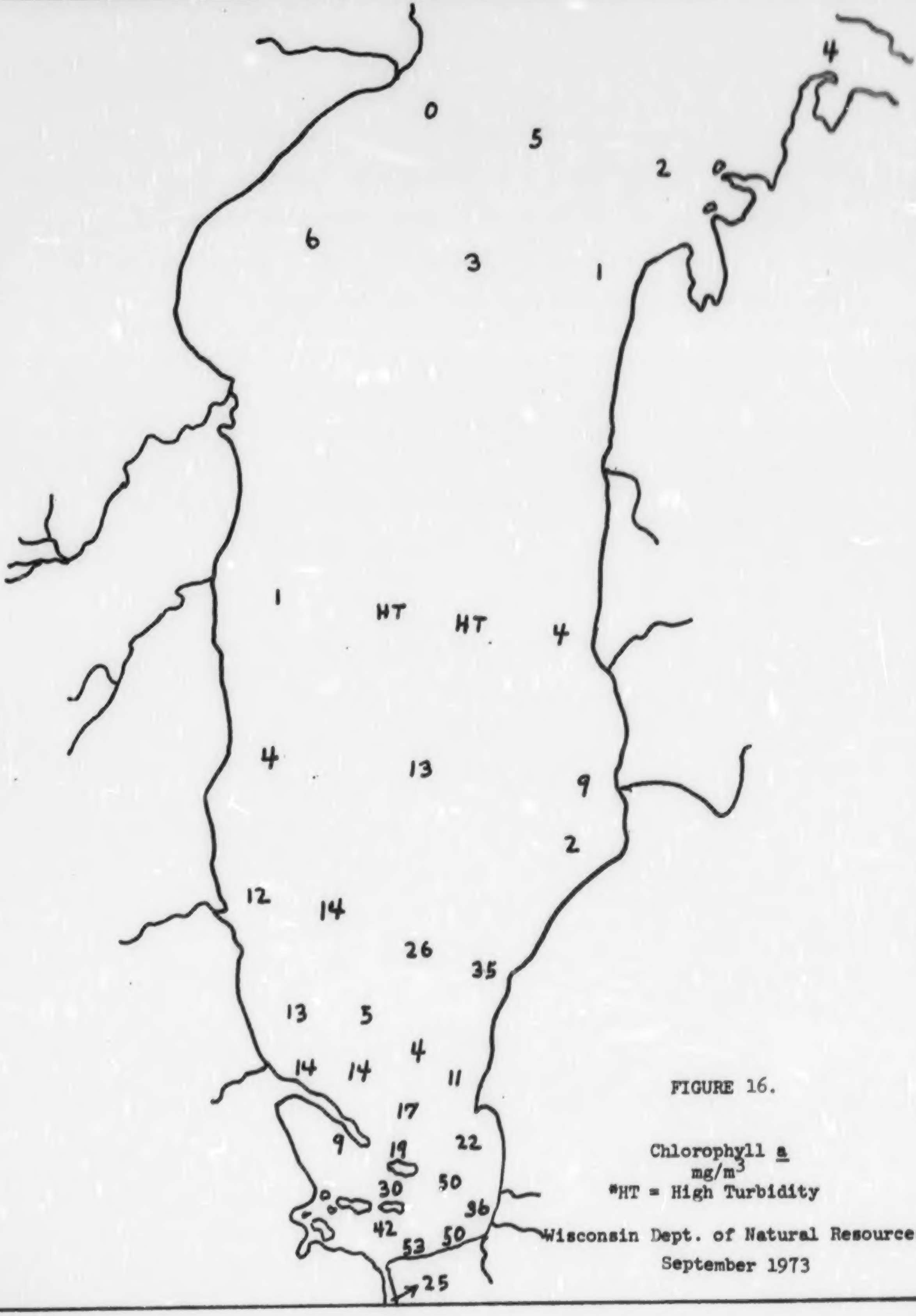


FIGURE 16.

Chlorophyll a
mg/m^3
*HT = High Turbidity

Wisconsin Dept. of Natural Resources
September 1973

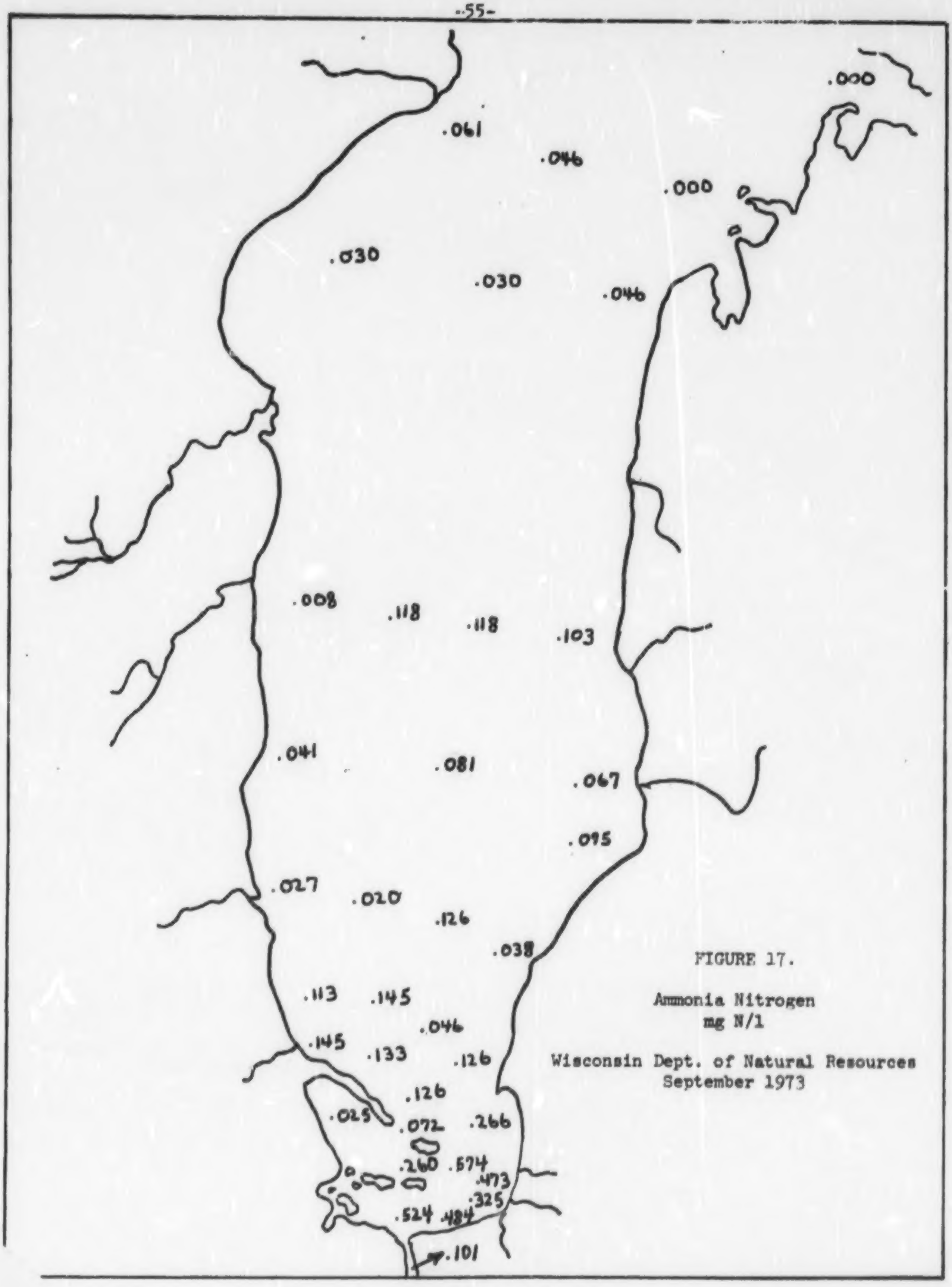


FIGURE 17.

Ammonia Nitrogen
mg N/1

Wisconsin Dept. of Natural Resources
September 1973

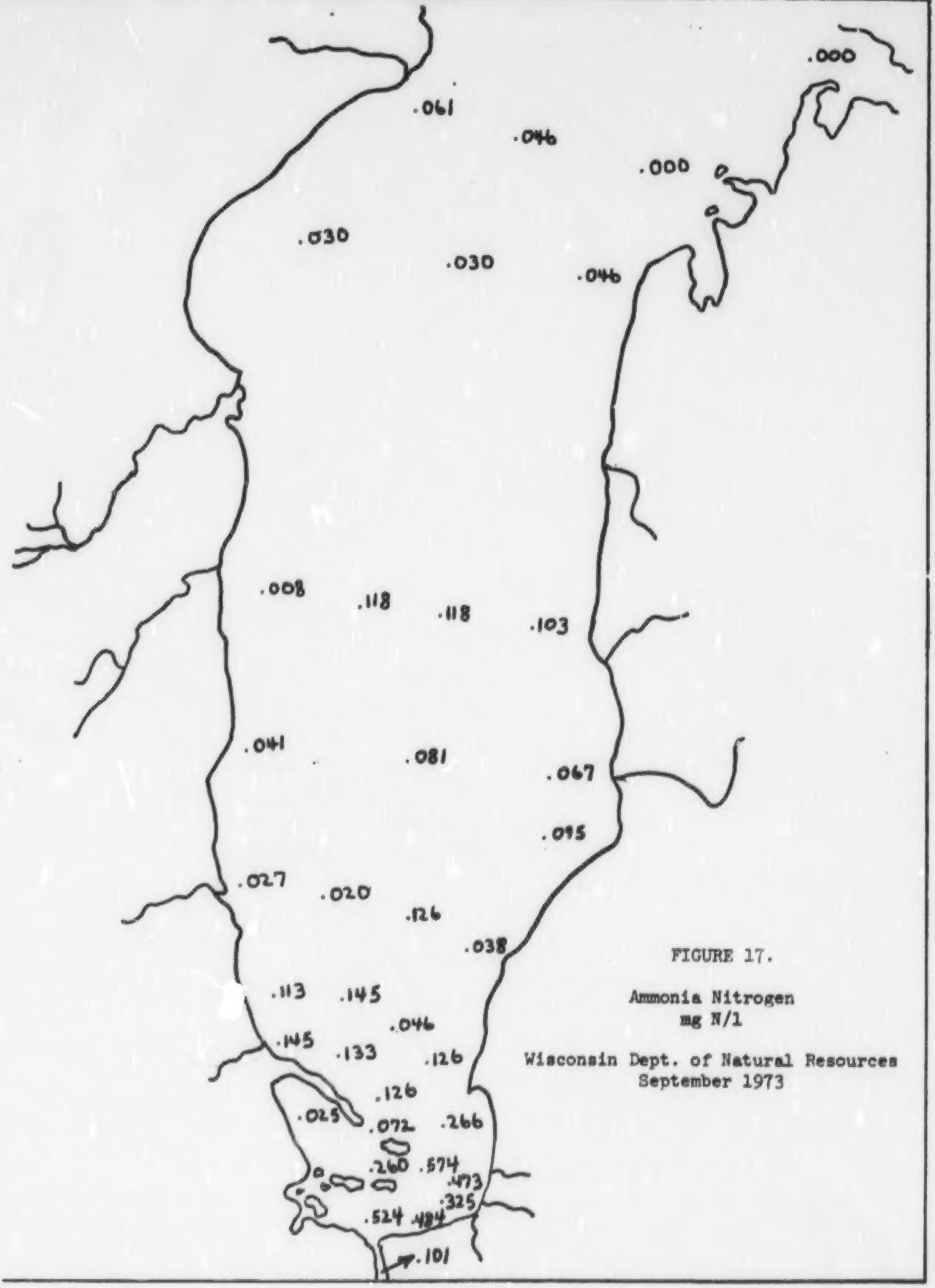


FIGURE 17.

Ammonia Nitrogen
mg N/1

Wisconsin Dept. of Natural Resources
September 1973

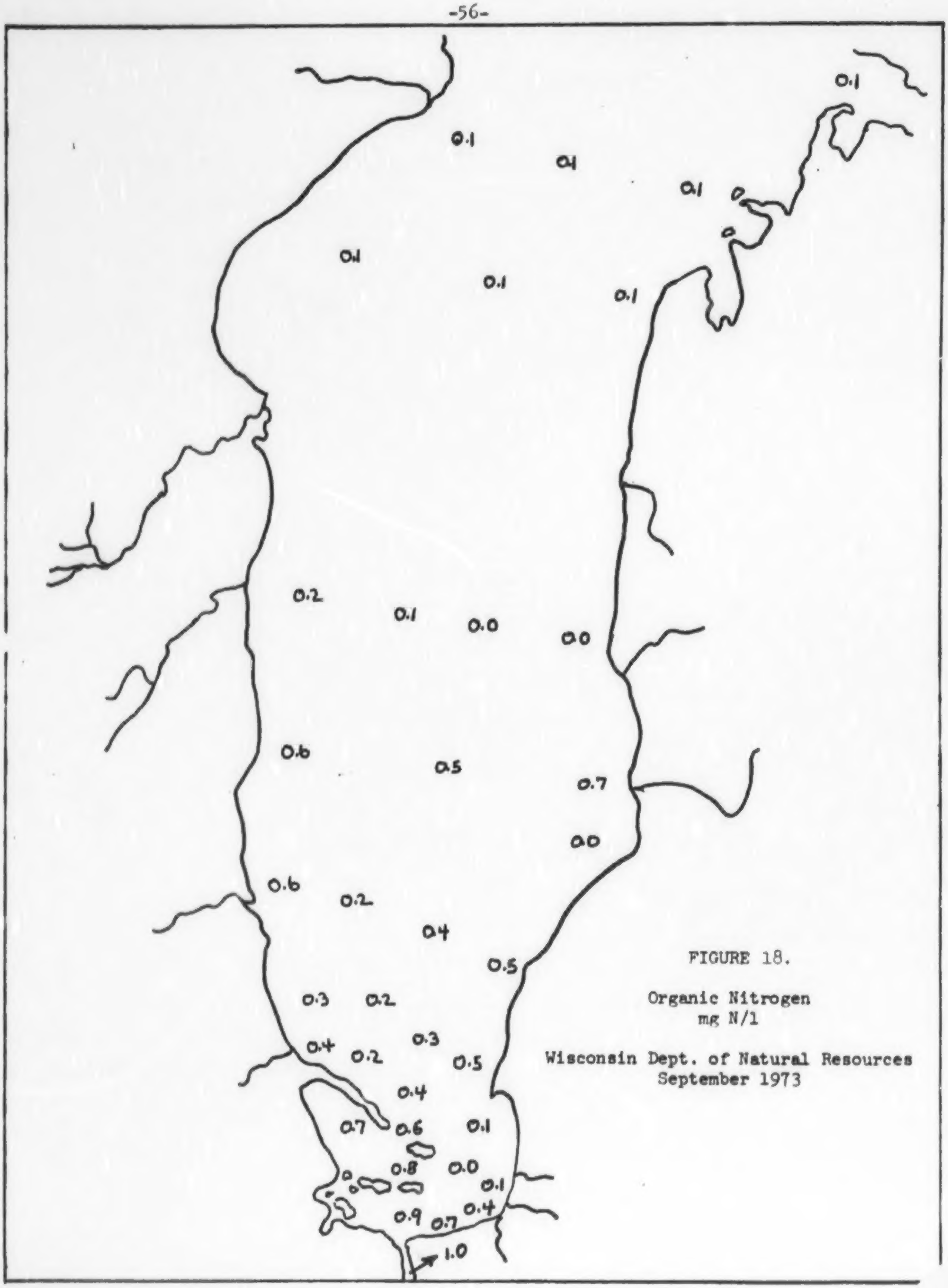


FIGURE 18.

Organic Nitrogen
mg N/1

Wisconsin Dept. of Natural Resources
September 1973

MIXING, DISPERSAL AND TRANSPORT OF WATER IN GREEN BAY

The movement of water in Green Bay depends upon several factors. One of these is the oscillation of water in a bay, lake or landlocked sea known as a seiche. Seiches have been noted in Green Bay since the time of the earliest French explorers, although the changes in height are not exceptionally large. Both Father Marquette (Bacqueville de La Potherie, 1722) and Father Andre in 1677 (Martin, 1916) observed water movements in Green Bay which were described as tides.

Indications are that the daily changes in the Green Bay water level that are called seiches are due to atmospheric pressure as well as wind direction and velocity. These variations can extend to the lower portions of tributary streams. Streamflow reversal has been observed on the East River which joins the Fox River about 2.3 km from the Bay. This reversal has been observed as far as 7.4 km along the East River (Schraufnagel et al, 1968).

That rapid changes in water levels can occur was documented during a survey of the Fox and East Rivers in 1956-1957 (Scott et al, 1957). The level of the East River was observed to vary by 1.43 meters over a period of one year. A substantial change took place in a very short time. On November 18-19, 1957, the elevation of the East River changed by 1.33 meters in a period of 17 hours. The usual change in river elevation is approximately 0.3 meter per day but occasional changes of only 0.03 or 0.06 meter occur between reversals. Fluctuations of water level in the Bay may cause a reversal of flow in the Fox River. The effect has been noticed as far as the De Pere dam, a distance of 11 km (Schraufnagel et al, 1968). On one occasion, flow on the Fox River near its mouth was measured at slightly over 280 m^3/sec and it was moving upstream.

In the late fall and in the spring, winds from the direction of Lake Michigan bring in large quantities of fresh lake water which are trapped in the Bay. This influx is less important than that from the input of lake water through the many passages between the Bay and the lake. Seiche motion is the cause of this latter input. The associated current reversals occur typically every twelve hours. Surface water leaves the Bay while water at lower depths enters. Although the net flow is outward, this mechanism does provide a source of fresh Lake Michigan water which is then subject to the independent circulation of the Bay (U.S. Federal Water Pollution Control Administration, 1966).

The influence of seiche motion in Green Bay has been investigated by Mortimer (1965), Saylor (1964) and Johnson (1960, 1962, 1963). It is found that the Bay has a restricted exchange of water with the rest of Lake Michigan which minimizes dilution and flushing processes. Eventually all of the water that flows into Green Bay flows out into Lake Michigan, but these flows are probably small in comparison to the water movements associated with the currents and seiches (Schraufnagel *et al*, 1968).

Wind and current patterns play the most important roles in the mixing and transport of water within Green Bay. The wind patterns in Green Bay for late summer and early fall show that the prevailing winds are from the west through the southwest (U.S. Federal Water Pollution Control Administration, 1966). For the late fall and winter, the prevailing winds are from the west through the northwest. During May to August, the prevailing winds are from the south through the southwest. Early spring (April) and late fall are the only times when the prevailing winds are from Lake Michigan. The effect of a northeast wind can be enormous. In the spring of 1973, the community of Green Bay was hit with the worst flooding in its history. Ninety km per hour winds brought three meter waves crashing into the city, while 6 meter waves pounded the neighboring shoreline.

Green Bay becomes thermally stratified weeks before the adjacent deeper water of Lake Michigan. The shallow southern end of the Bay is nearly 7°C warmer than the deeper north end in June, and more than 12°C warmer than the deeper lake water. Measurements in June, 1962 and May and June, 1963 show that thermal stratification in Green Bay is separate from stratification in the main portion of the lake (U.S. Federal Water Pollution Control Administration, 1966). The effects of temperature and wind appear to make Green Bay into an independent lake separate from Lake Michigan.

It has been suggested (Ragotskie, Ahrnsbrak and Synowiec, 1969) that bays of the Great Lakes can, in some ways, be considered analagous to coastal estuaries of the oceans. However, the primary physical mechanisms effecting the dispersal and transport of pollutants may be quite different from those acting in a tidal estuary. Seiches provide an analagous but more complex forcing mechanism for horizontal water movement, and density gradients are entirely due to thermal and diffusion effects with no salinity contribution.

Several features of Green Bay make it desirable for the study of water movement in a freshwater bay. First, the long, narrow shape of the basin makes it ideal for diffusion and dispersal studies. The rather limited exchange of Bay waters with those of Lake Michigan make Green Bay an almost separate lake. Secondly, the major portion of pollutants enter at the head of the basin and act as a tracer for the movement of water through the Bay.

Recently there have been studies aimed at a description of the movement of polluted Fox River water in Green Bay. Ahrnsbrak and Ragotskie (1970) have described mixing processes in the Bay. Modlin and Beeton (1970) have described the dispersal of Fox River water in Green Bay. For these studies, the assumption has been made that the Fox River is the only significant source of pollutants which enter the Bay. The data in Table 11 support this assumption.

TABLE 11. Average discharge rates of water, suspended solids, and chlorides for 4 rivers entering the southern lobe of Green Bay.

River, Location	Discharge Rate ($m^3 \cdot day^{-1}$)	Suspended Solids Concentration ($mg \cdot l^{-1}$)	Suspended Solids Net Transport ($kg \cdot day^{-1}$)	Chlorides Concentration ($mg \cdot l^{-1}$)	Chlorides Net Transport ($kg \cdot day^{-1}$)
OCONTO at Oconto	2.35×10^6	9.8	2.3×10^4	6.7	1.57×10^4
MENOMINEE at Marinette	8.96×10^6	5.3	4.75×10^4	1.4	1.25×10^4
PESHTIGO at Peshtigo	2.25×10^6	5.6	1.26×10^4	0.6	1.35×10^4
FOX at Green Bay	11.3×10^6	17.1	19.3×10^4	12.3	13.9×10^4

AHRNSBRAK and RAGOTZKIE (1970)

The four significant rivers which enter the southern two-thirds of the Bay are given with their average discharge rates, concentration of chlorides and suspended solids, and the net transport of those pollutants. Based on these flows, it can be seen that as a pollution source, the Fox River is nearly an order of magnitude larger than the other three rivers combined.

Modlin and Beeton (1970) used conductivity measurements as a probe of the lakeward movement of Fox River water in Green Bay. In 1968, they found a counterclockwise circulation of the surface water in the southern end of Green Bay below the Oconto River and above Long Tail Point. As a result, water which they described as river water extended northward for almost 40 km along the east shore. Lake Michigan water appeared to occupy the western two-thirds of this area. The lakeward movement of the Fox River water is generally along the east side where it may constitute as much as 80 percent of the northward current. These observations are consistent with those of Schraufnagel et al (196) who suggest that the river water may frequently become well dispersed across the lower 16-24 km of the Bay. They suggest that a counterclockwise current brings cleaner water down the western shore of the Bay, sweeps eastward at about the latitude of the Green Bay harbor entrance light and then moves northward in the eastern half of the Bay. The usual pattern of currents found by Schraufnagel et al (1968) is for Fox River water to continue in a northerly direction into the Bay for about 15 km and then veer to the east and follow the east side of the Bay northward to Little Sturgeon Bay. Movement of the water along the west side of the Bay is southward to near Pensaukee and then eastward and northward. The southern part of this counter-clockwise current lies in the vicinity of the two outer channel lights.

Schraufnagel et al (1968) suggest that there appear to be pockets in the lower Bay which permit little water movement in and out. On occasions the waters of the Fox River, although somewhat concentrated along the shipping channel, appear to be fairly well dispersed across the lower 16 to 24 km of the Bay. Density measurements indicate that in summer months the warmer river waters overflow the lake waters, but in the winter months, the river waters tend to follow the bottom for some distance before diffusing into the main body of water.

The conditions at the extreme southern end of Green Bay (below Long Tail Point and the sand bar extending towards it from the east) drew special attention from Modlin and Beeton (1970). They found in 1968 that approximately 70 percent of the water in this region was river water. Ahrnsbrak and Ragotskie (1970) concluded from conductivity studies that the water below Long Tail Point consists of 50 to 80 percent by volume of Fox River water. Under southerly winds, a tendency for a tongue of water with a concentration of 30 to 40 percent river water can be identified extending northward along the east side of the Bay approximately 15 to 20 km. However, under the influence of northerly winds, this tongue was not observed. North of Long Tail Point, the concentration of Fox River water decreased rapidly (as shown by conductivity measurements), a value greater than 25 percent seldom being observed beyond 25 km north of the mouth of the river. Northward concentrations are described as very low and the effect of the Fox River is described as small. From diffusivities derived from their data, Ahrnsbrak and Ragotskie (1970) suggest the existence of a barrier to horizontal mixing in the area of Long Tail Point, while northward the Bay appears to be well mixed and the transit of Fox River water is much more rapid. They postulate that Long Tail Point and the bar extended towards it from the east are effectively the outfall site for the effluent of the Fox River water in Green Bay. Similarly, Sager (1971) describes two discreet water masses in lower Green Bay, one characteristic of the Fox River water and the other representative of the water of Green Bay.

The distribution of suspended solids is also a measure of the flow and dispersal of river water in Green Bay. Recent estimates of suspended solid concentrations at the mouth of the Fox River range from 7 to 20 mg/l (Sager, 1971; Ahrnsbrak and Ragotskie, 1970).

Sager (1971) measured light penetration by means of Secchi disc readings throughout the summer of 1970 at several stations along a line extending 22 km from the Fox River mouth. He found that there was a consistent pattern of increase along the sampling transect, but with the steepest gradient noted in the first 5 to 7 km. The decrease was ascribed to both dilution and sedimentation processes. Low transparency in the inner Bay area was affected by phytoplankton concentrations and suspended solids from the sediments in the extensive regions where the water depths are generally less than 2 to 3 meters. Here the bottom sediments are subject to wind-induced turbulence.

Schraufnagel et al (1968) measured light transparency in Green Bay during the summer of 1966. The Bay was divided in subregions as shown in Figure 19.

The result of their measurements is shown in Table 12.

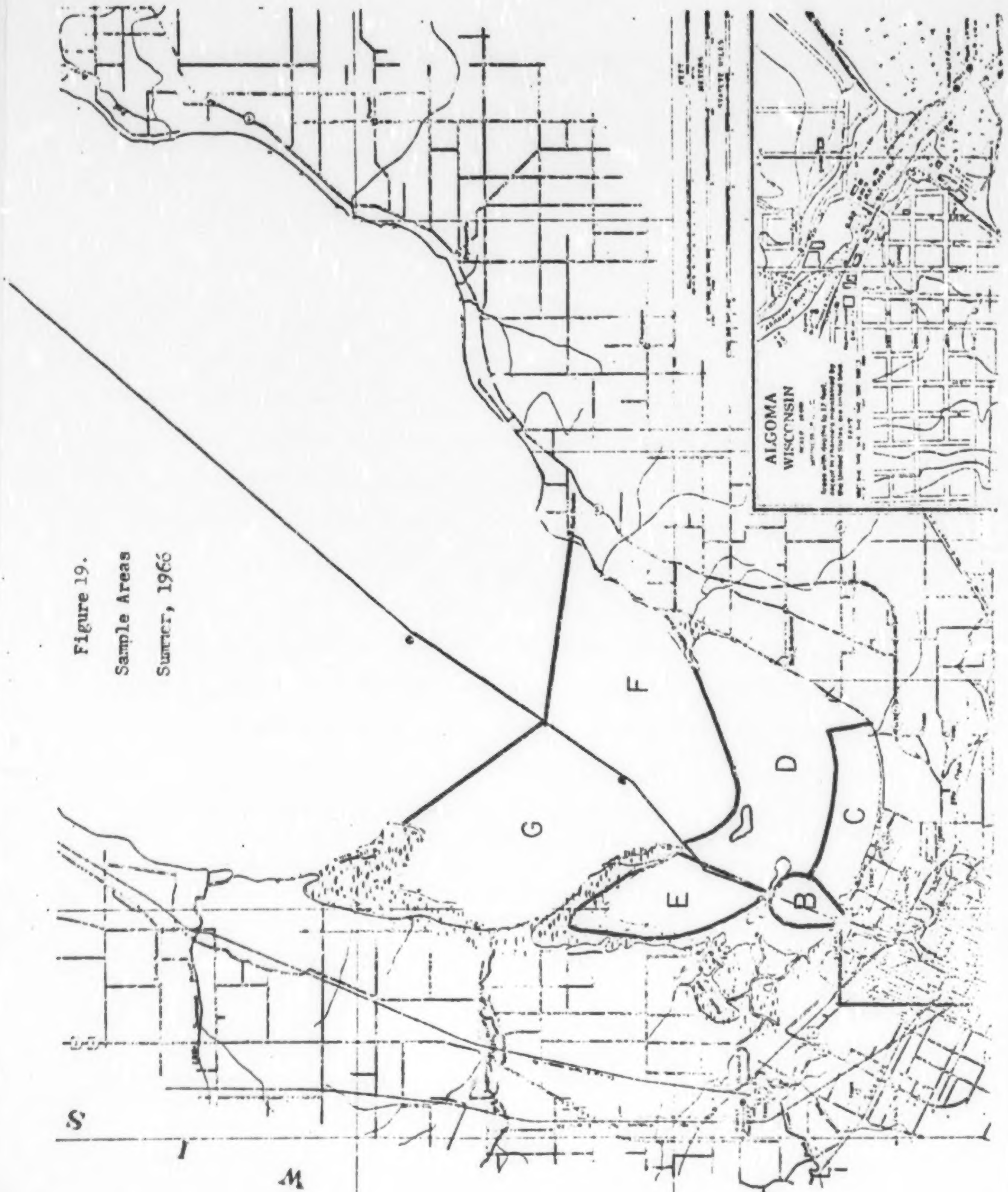


Figure 19.
Sample Areas
Summer, 1966

TABLE 12. LIGHT TRANSPARENCY IN GREEN BAY (SECCHI DISC DEPTHS) SUMMER, 1966.

Zone	Secchi disc Readings	Approximate Distance from Mouth
A	0.45--0.60 meters	0 km
B		2
C	0.30--0.90	2-3
D	0.30--0.90	3-4
E	0.45--0.60	3-4
F	0.90--1.2	
G	0.90--1.2	
Entrance light	1.5 --1.8	17
Middle Green Bay	1.8 --2.1	
Sturgeon Bay	2.7 --3.0	56
Washington Island	4.9 --6.0	112

The investigation in 1938/1939 (Wisconsin Committee on Water Pollution, 1939) did not measure light transparencies. However, measurements were made of the total solids (ppm = mg/l) in each water sample. The total solids content decreased consistently with distance from the Fox River mouth.

Modlin and Beeton (1970) used conductivity measurements to estimate the flushing rate in lower Green Bay. Flushing rate is defined as the length of time it takes one day's accumulation of river water to move through a bay or portion of a bay. The longer the flushing rate, the greater the effect the river water has on an area. The results are shown in Table 13.

TABLE 13. AVERAGE CONDUCTIVITY, PERCENTAGE OF RIVER WATER AND FLUSHING TIMES FOR TWO ZONES IN LOWER GREEN BAY

Zone 1 is the area below Long Tail Point; Zone 2 is the area above Long Tail Point, north to an east-west line at Oconto.[a]

Date/Zone		Average Conductivity umhos at 25° C	Percent River Water	Flushing Time Days
1968/1	(July)	345	70	29
2		277	15	78
1969/1	(August)	340	64	33
2		279	16	127

[a] Modlin, R. F. and A. M. Beeton. Dispersal of Fox River water in Green Bay, Lake Michigan.

The effect of river discharge rate can be seen in this data. The river discharge rate in August, 1969 averaged 5.9 x 10^6 m^3/day. For this flow, the net flushing rate was 160 days. In July, 1968, the discharge was greater by almost 3 x 10^6 m^3/day and, consequently, the flushing rate decreased to 107 days. Under normal flow conditions, the residence time of Fox River water in the lower Bay is considerable.

NATURE AND CONSTITUTION OF THE BOTTOM SEDIMENTS

An understanding of the relationship between the bottom sediments and the sources of materials which enter Green Bay requires a knowledge of the type and distribution of these sediments. Qualitative and semiquantitative descriptions of bottom sediments have been a part of the extensive surveys in the Bay. In July, 1968, a comprehensive geological-geophysical survey of the shallow subbottom structure and near surface sediments of Green Bay was carried out by Moore and Meyer (1969). They were able to map the major textural types of deposits which floor Green Bay by means of a variety of techniques--heavy dredging, core sampling and acoustic and seismic profiling.

Figure 20 shows the naturally grouped sediment types. It shows that mud is the prevailing sediment type in the southern part of Green Bay, with sand the second most common type. Sand covers the western near shore areas of southern Green Bay. A strip of sand bottom varying between two and three miles in width apparently extends the full length of the western shore. Sand and sand mixed with mud also occurs at depth in the northern part of Green Bay and there the pattern suggests a trend parallel to the long axis of the Bay.

The bathymetric data from the 1968 survey was compared with the final worksheets of U.S. Lake Survey for the Southern Bay (1943) and the Northern Bay (1950). This comparison was judged by Moore and Meyer (1969) to be the most significant result from the 1968 survey. In the region of the Bay below Sturgeon Bay, there were several areas where the bottom depth decreased substantially over the relatively brief period of seventeen years. In Figure 21 the shaded areas indicate decreases in floor depth of more than 1.2 meter (four feet) or more than 0.6 meter (two feet). Moore and Meyer (1969) call attention to the relationship between the areas of the Bay where these decreases have occurred and the sediment and nutritive sources. An independent check of the validity of these results was also afforded by the overlap of the

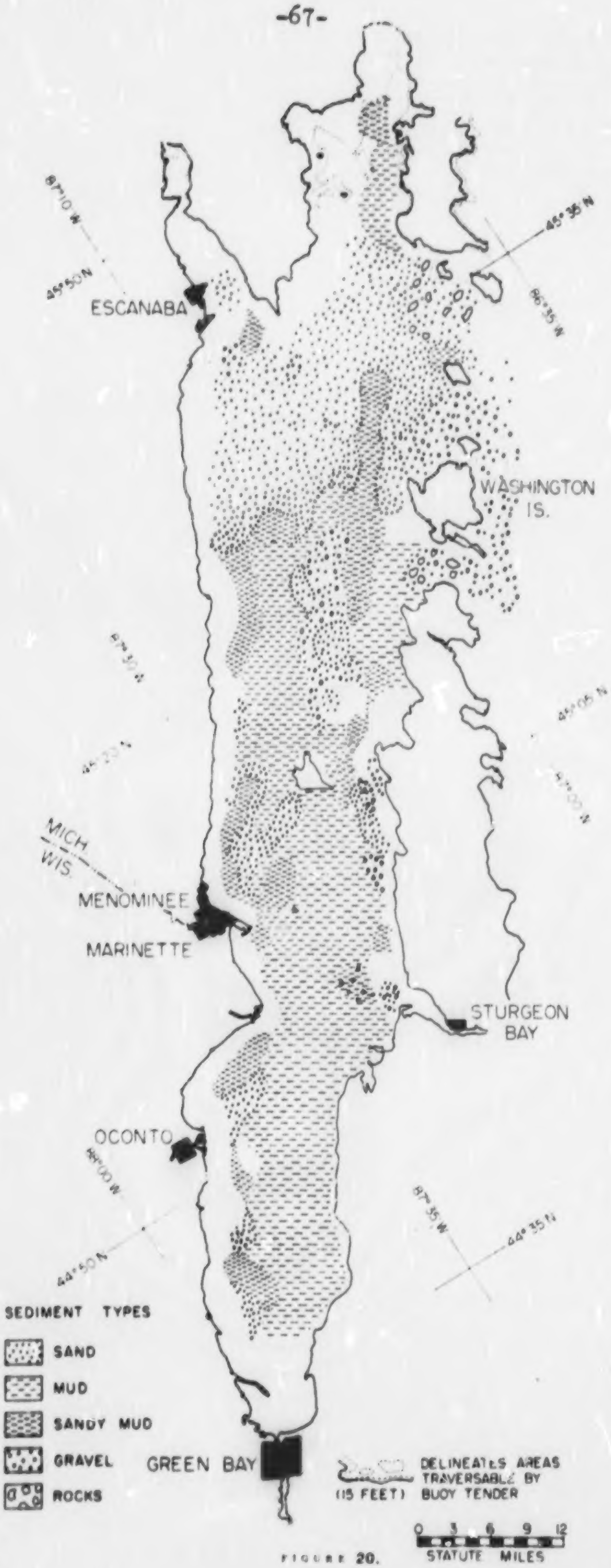


FIGURE 20.

Moore and Meyer (1969)

DIFFERENCES 1968 - 1950 or 1943
BATHEMETRY
SOURCES 1968 UNIV of WIS
1950 - 1943 LAKE SURVEY
▨ 1968 greater than 4 feet shallower
▥ 1968 greater than 2 feet shallower
● ENTRANCE LIGHT
STURGEON BAY
OCONTO
GREEN BAY

FIGURE 21.

Moore and Meyer (1969)

1943 lake survey bathymetric data south of the harbor entrance light and the 1950 data to the north. This comparison shows a decrease in depth of 0.3 to 0.6 meter (1 to 2 feet) in the seven years between those surveys in areas where equal or greater amounts of filling were found since 1950. The lake survey procedures were similar or identical in 1943 and 1950. Moore and Meyer (1969) raise the spector that Green Bay will cease to exist as a body of water because of the "extremely high" sedimentation rates.

The data were interpreted to indicate that Green Bay was filling in at a rate of 10 to 100 times that associated with larger bodies of water.

Distribution of dredged materials do not appear to influence these results. Maintenance dredging of the Green Bay ship harbor is done by the Corps of Engineers. The dredged materials are usually disposed of in deep waters (over 50 feet). A polluted zone is created when any organic matter is deposited in this way. In 1966, the Corps of Engineers constructed a diked area about 3.2 km north of Fox River mouth to be used as a depository of dredgings considered to contain pollutional material (U.S. Federal Water Pollution Control Administration, 1966).

Several investigators have described the bottom sediments in a qualitative way during the course of their studies of Green Bay bottom fauna. A description of the bottom sediments was part of the 1938/1939 survey (Wisconsin State Committee on Water Pollution, 1939). The result was a map of the sediment distribution of the lower Bay (Figure 22).

An area at the extreme lower end of the Bay contained a fairly high content of sewage sludge derived from a combination of the inflowing Fox River and the outfall of the Green Bay sewage treatment plant. Its decomposing condition was evidenced by the appearance and odor and by the fact that there were large numbers of gas bubbles when its supernatant water warmed up in the spring.

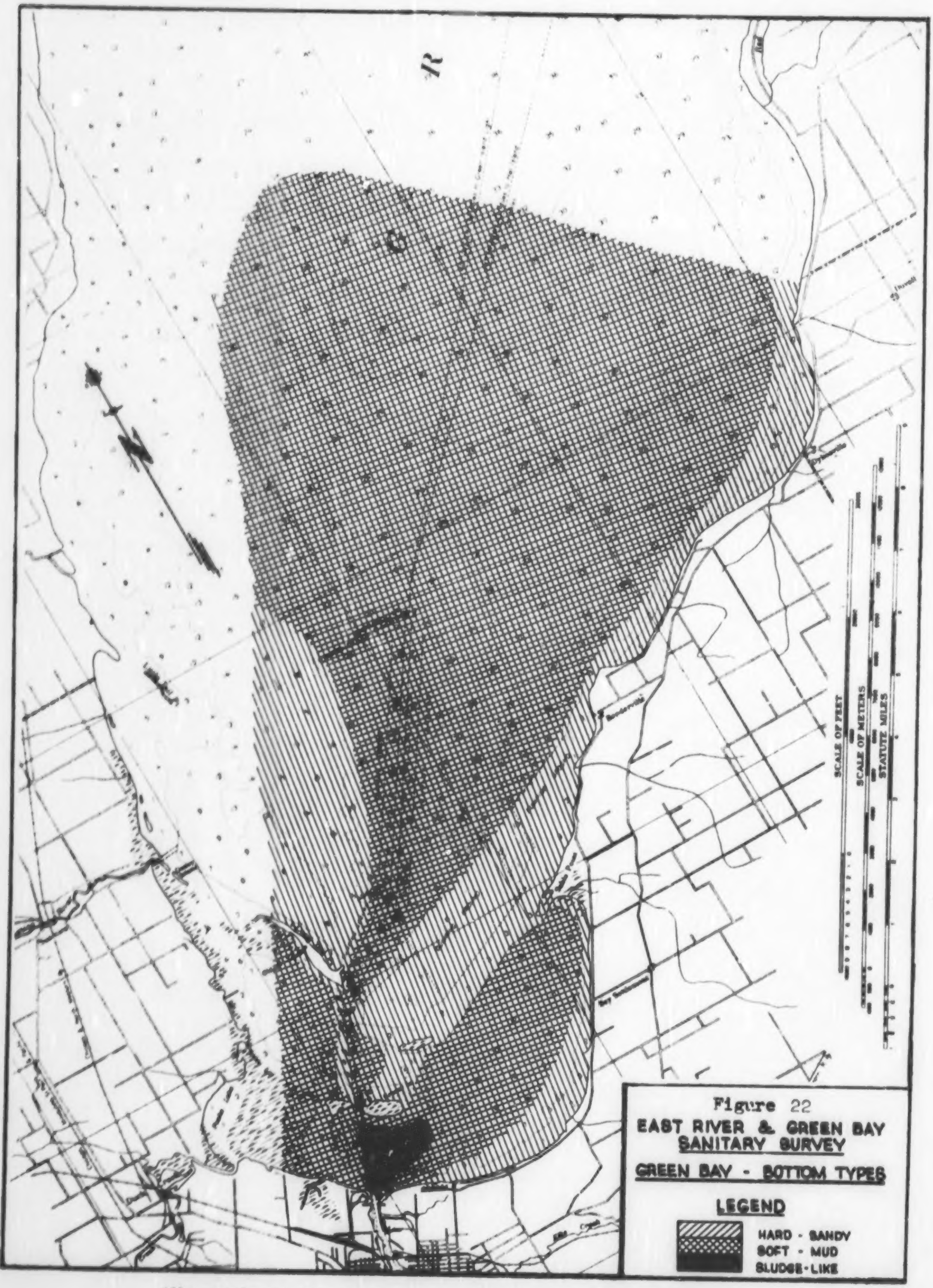


Figure 22
EAST RIVER & GREEN BAY SANITARY SURVEY

GREEN BAY - BOTTOM TYPES

Wisconsin State Committee on Water Pollution (1939)

Howmiller and Beeton (1970) have investigated the bottom fauna of Green Bay. In the course of this investigation (which is discussed in detail in a later section) they describe the bottom material within a few kilometers of the Fox River as a semi-fluid black-brown mud which resembles sewage plant sludge. It appeared to be highly organic, smelled of sewage and hydrogen sulfide, and contained many small vegetable fibers. Brown silt was common northeast of Long Tail Point and along the eastern shore where the mixture of lake water and river water moves northward. Brown mud, more cohesive than silt or the semifluid mud of the lower Bay, occurred in the deeper water further north in the Bay.

FISHERY IN GREEN BAY

This section is designed to highlight those aspects of fishing in Green Bay which can be related to water quality in the Bay rather than designed to be an extensive survey.

Lloyd (1966) has sketched the background of Green Bay fishing. Much of the historical information is qualitative and is expressed in superlatives. Natives and travelers did most of their fishing on many of the large tributary streams and took advantage of migratory fish runs. Father Andre, a French priest, wrote in 1674 that it was impossible to conduct church services because of the immense pile of drying fish which created objectionable odors.

The Indians built a fish weir across the Fox River from which they speared northern pike, sturgeon and muskellunge. As communities stabilized, a productive commercial fishery developed. Pike, whitefish, herring and sturgeon were taken in large quantities in the 1850's.

The first annual report of the Wisconsin fish commissioners in 1874 indicated a concern about the decline of fish populations, especially whitefish and trout. In an effort to offset declining numbers of fish, a hatchery was constructed at Pensaukee in 1875 to hatch lake trout and whitefish spawn for stocking Lake Michigan. In 1877, one million whitefish fry were stocked in Green Bay. The first lake trout eggs were stocked in 1880. At this time, regulatory rules were developed to protect declining fish populations.

The present character of the fishing industry varies considerably over the various regions of the Bay.

The northern bays adjacent to Michigan's Upper Peninsula have shallow, warm waters which support walleye populations sufficient for commercial fishing. The northern part of Green Bay has deep and cold water where species of fish appropriate to this habitat are caught in great numbers. Ports like Gills Rock in Door County have been centers for fall herring and spring whitefish fishery. Here the lake trout was the predominant preaaceous fish in years past.

Southern Green Bay has a predominance of warmwater species with perch most important. Carp, northern pike, drum, suckers, white bass, bullheads and catfish also occur here. The principal predaceous fish is the northern pike. Perch occur in waters less than 25 meters deep throughout the Bay. New species which have entered recently have wide distribution ranging from the shallows of estuaries to the greatest depths. Both the smelt and alewives are in this category.

The commercial fishing industry in Green Bay constitutes a considerable proportion of the total production in Green Bay. The data (Table 14) show that in recent years, as well as in the past, the commercial fish catch in Green Bay has constituted approximately one-half of the total catch throughout Lake Michigan.

The fish populations of Green Bay have fluctuated violently since the mid-forties and to a lesser extent in the period 1929 to 1946. These fluctuations have been interpreted as the expression of year class strength operating within the influences of a well-developed fishery. However, details of population growth or decline remain unknown. The species may affect each other as indicated by the recent near extinction of one species followed by the explosive growth of others. The comments of Patten (1969) may well apply to Green Bay: "Alter or adjust a population here and remote, unforeseen consequences may be generated, possibly dramatically elsewhere. And if long enough time lags or distances separate primary causes and ultimate effects, an event may never be associated with a reaction which in fact it initiated." Recently, Walter and Hogman (1971) have constructed a mathematical model which incorporates statistical feedback

TABLE 14

COMMERCIAL FISH PRODUCTION OF GREEN BAY IN RELATION TO LAKE MICHIGAN (IN THOUSANDS OF POUNDS)

Year	Green Bay Production	Pounds Per Acre Yield	Lake Michigan Production	Percent of Total From Green Bay
1949	15,768	16.4	25,573	61.7
1950	15,654	16.2	27,078	57.8
1951	15,273	15.9	27,648	55.2
1952	18,803	19.6	32,061	58.6
1953	15,875	16.5	28,834	55.1
1954	17,510	18.3	30,291	57.8
1955	16,637	17.4	30,036	55.3
1956	17,038	17.7	30,798	55.3
1957	13,389	13.9	27,223	49.2
1958	13,610	14.2	27,771	49.4
1959	10,033	10.4	20,808	48.2
1960	8,444	8.8	24,311	34.7
1961	7,447	7.8	25,559	29.1
1962	7,035	7.3	23,475	29.9
1963	6,636	6.9	21,021	31.6
1964	7,261	7.6	26,201	27.7
1965	5,292	5.5	26,994	19.6
1966	15,512	16.1	42,764	36.3
1967	27,871	29.0	53,496	52.1
1968	19,336	20.1	45,810	42.2
1969	23,102	24.0	47,489	48.6
1970	25,226	26.2	49,914	50.5

From: U. S. Bureau of Commercial Fisheries, Report on Commercial Fisheries Resources of the Lake Michigan Basin, 1965, (for data previous to 1964) and Michigan, Ohio and Wisconsin Landings, Current Fisheries Statistics, (U. S. Department of Commerce) National Marine Fisheries Service, (for reports since 1964).

and considers a large set of system variables which may affect each species' rate of abundant change. The model has the capacity to respond to changes in water quality. However, these changes, which are of considerable importance, do not enter because of lack of a qualitative relationship between water quality and population.

The nature of the commercial fishing industry on Lake Michigan has changed dramatically in the past thirty years. The judgment is inescapable that this change has resulted from the activities of man. It is difficult to assess the effect of water quality on changing fish populations in the presence of so large an influence. Nevertheless, some factors can be identified. Smith (1968) has pointed out that commercial fishing for sturgeon was prohibited in 1929, long before the recent large influences. It was suggested that the environment for sturgeon was no longer suitable, since it was usually more abundant in those areas that had suffered the severest pollution. The decrease in lake herring in Lake Michigan was enormous in the period 1954-1962 when the alewife was becoming abundant in the lake. The lamprey, as well as the alewife, has probably contributed to the decline of the lake herring, but it should be noted that the major lake herring fishery was in Green Bay, where accelerated eutrophication may well have contributed to the collapse of the lake herring population.

Lloyd (1966) and Beeton (1969) have discussed the habitat in which various species exist. The following is a summary of their work. An emphasis has been placed on the identification of changes in habitat which are related to changes in water quality.

Cold-Water Species

Lake trout has disappeared from the Bay fishery although they are beginning to reappear in small numbers as a result of stocking. The primary factor responsible for their disappearance was the lamprey. However, it has been suggested

(Lloyd, 1966) that the lamprey cannot be regarded as the only cause for decline. Increased fertilization of the Bay places a higher oxygen demand on the deep, cold waters which could force the lake trout out of some of its preferred habitat.

Whitefish have also been affected by lamprey depredations and their numbers since the 1940's have been much less than during the prelamprey period. They also are affected by increased enrichment and could have been squeezed out of acceptable habitat.

Chubs, known as deep-water cisco, frequent deep, cold waters. They were never a large component of the Green Bay fishery. Although small in size, and therefore not the chosen prey of the lamprey, the decline closely coincided with the increase in alewives.

Lake herring or shallow-water cisco has been the most important catch in these waters. Exceptionally high populations occurred immediately following lamprey reduction of the predaceous lake trout. As alewife numbers rose, cisco declined. Eutrophication also contributed to a declining habitat, a subtle factor which will never be adequately measured.

Smelt were first detected in Lake Michigan in the 1920's. They reached a peak in the 1940's and 1950's and have declined somewhat since. The ultimate population is not likely to be as high as the early peaks.

Alewives were first detected in 1952 and became a part of commercial catches in 1956. Within ten years they became the dominant species in the fishery industry despite their low commercial value.

Warmwater Species

Warmwater species are found in the shallow waters, southern Green Bay, the estuaries and bays.

Lake sturgeon have become a fish which is only occasionally found in the commercial nets. This long-lived primitive fish lost its spawning grounds among the rocks of the large rivers when they were cut off by dam building and pollution.

Northern pike are a product of shallow water. Most of the commercial catch is made on the west shore of southern Green Bay. There has been a steady erosion of spawning areas as harbors expand and marshes adjoining the Bay are filled or drained.

Walleye is found in abundance in the Northern Bays in Michigan. They move to Oconto on the west and the Strawberry Islands on the east shore.

Perch have been the most important marketed catch. Long-term changes in abundance are not evident. Perch abundance does not appear to be significantly affected by more adverse environmental conditions including low dissolved oxygen concentrations; their spawning grounds are not affected as they will spawn over sandy or rocky bottoms amid vegetation or debris. Their primary food supplies, consisting of either plankton or bottom fauna, may be increased by enrichment.

Carp are found in shallow, warm water of the Bay. They exist in water with low dissolved oxygen; they feed on plankton, bottom fauna or vegetation and spawn in this environment. Thus, enrichment of the Bay favors this fish.

Summary

The fishery in Green Bay has changed radically in recent years due to the activities of man. The result has been a shift of production from primarily high quality native species to low quality exotic fish.

Pollution has caused a deterioration of the cold-water habitat and has rendered previously desirable spawning grounds as useless. Enrichment has accentuated plant growth which favors carp. In addition, fishermen complain of fish with off flavors, probably a direct or indirect result of pollution.

BOTTOM FAUNA

A biological evaluation of natural water includes a consideration of the conditions for phytoplankton, zooplankton, vertebrate (fish) and invertebrate organisms. The invertebrate organisms are particularly useful for investigations of water quality since they are relatively immobile and consequently are directly subjected to any polluted conditions in their habitat. If they are subjected to the influences of a contaminant, then they must respond by a physiological adaptation or they must die.

All gradations and variations of adaptability toward adverse conditions may occur. Some species cannot tolerate any appreciable pollution whereas others are not only tolerant but appear to thrive. Intolerant species may be reduced in numbers or disappear. Tolerant forms respond according to the severity of the pollution. When competition is reduced by the elimination of more competitive intolerant forms, the population of the more tolerant forms may increase.

Pollution normally expresses itself on the bio-habitat and aquatic organisms in one of two ways. It may be toxic to the organisms and, in this situation, the substance will usually affect all organisms uniformly. Here one does not observe a specific group which becomes more or less predominant. The tendency is for the disappearance of all species simultaneously. This situation is most often noted with wastes which contain heavy metals, tars or oils, chlorinated hydrocarbons or other more exotic materials. Alternately, pollution may cause changes in the environment which favor certain species of organisms and is detrimental to others. This is the situation most frequently observed with organic types of pollution, such as paper mill wastes, milk plant wastes, sewage treatment plant wastes, etc.

Aquatic organisms must derive their oxygen from the water and, consequently, when an organic waste decomposes, it competes with the organisms for the oxygen present. Generally, if decomposition is rapid and natural reaeration replaces lost oxygen, then significant levels of dissolved oxygen will remain in the water. This situation often exists at summer temperatures. However, if decomposition continues for lengthy periods, oxygen levels may be reduced to critical levels for animals that are not adapted for the most efficient use of dissolved oxygen. Some organisms are not only efficient at extracting oxygen from the water but may also derive oxygen from the air and utilize waste organic material for food. Increasing numbers of these kinds of bottom organisms are a useful measure of polluted waters.

Since 1938, there have been several extensive chemical and biological surveys whose aim has been to assess the severity and extent of pollution in Green Bay (Wisconsin State Committee on Water Pollution, 1939; Surber and Cooley, 1952; Balch et al, 1956; U.S. Federal Water Pollution Control Administration, 1966; Schraufnagel et al, 1968; Howmiller and Beeton, 1970, 1971). As a part of each of these surveys, bottom samples were collected for analysis of benthic invertebrate animals. These analyses included classification of types as well as a count of bottom dwelling animals.

Surber and Cooley (1952) compared numbers and types of organisms at nine of their stations in the lower Bay in May, 1952 with data from nine comparably located stations sampled during the period November, 1938 to February, 1939 (Wisconsin State Committee on Water Pollution, 1939). In both studies, the predominant species in lower Green Bay were found to be the pollution tolerant Oligochaete (Tubificidae), commonly known as sludgeworms, and midge larvae (Chironomidae).

A comparison of the numbers of these species for 1938-39 and 1952 appears in Table 15.

TABLE 15

Comparison of 1938-39 Bottom Fauna Data With Data Collected on May 26 and 27, 1952

Number Per Square Foot

1952 Station Number	Comparable 1938-39 Station Number	1952 Tubificidae	1938-39 Tubificidae	1952 Chironomidae	1938-39 Chironomidae
2	S-11	10,516	2,200	128	270
3	G-29	3,144	20	288	64
4	G-30	4,756	4	152	2
5	G-11	1,252	8	156	100
6	G-31	912	4	164	180
8	G-17	132	2	212	38
10	G-9	72	None	108	None
12	G-7	196	None	156	72
14	G-5	84	None	144	None

From: Surber and Cooley (1952)

The increase in numbers of these pollution tolerant species led Surber and Cooley to conclude that there was an increase in pollution during the intervening thirteen years. The complete data from the 1938-39 and 1952 surveys appears in Appendix VII.

A survey by Balch et al (1956) was carried out in January, 1955. The samples from Inner Green Bay (that portion south of a generally east-west line from Long Tail Point to Point Sable) indicated a limited population of bottom-dwelling invertebrates. The fauna of Inner Green Bay was composed principally of pollution tolerant midge larvae and sludge worms. Numbers of midge larvae varied from 0 to 172 per m^2 and were restricted to four species. Numbers of worms varied from 0 to 2,627 per m^2. Numerous samples contained no living invertebrates.

Samples from Middle Bay (Long Tail Point to Little Tail Point) contained a large population and wide variety of bottom-dwelling species. The species were of the tolerant or very tolerant varieties.

Outer Bay (north to Sturgeon Bay) contained the most varied invertebrate population of the study. The complete data from the 1955 survey appears in Appendix VIII.

The possibility that January samples were not taken at a population peak was specifically dismissed. It was then concluded that there had been a marked reduction in the numbers of these forms compared to numbers obtained in the earlier studies. This judgment has been criticized by Howmiller and Beeton (1970) who have shown that the population of bottom organisms varies widely during a period of several months.

A survey in 1962-63 (U.S. Federal Water Pollution Administration, 1966) included bottom fauna counts. Unfortunately, the time of year when samples were collected was not specified and the results were expressed as total count of bottom fauna with only qualitative reference to type of animal. Total populations in 1962 and 1963 ranged from 5,000 to 15,000 organisms per square meter near the Fox River mouth, mostly sludgeworms and bloodworms. The numbers fell to about 500 organisms per square meter 16 km out into the Bay. Some pollution sensitive snails were found about 8 km from the mouth of the Fox River. The concentrations of bottom fauna obtained in the 1962-63 study are shown in Figure 23.

At the same time, benthic populations of 2,000 to 5,000 organisms per square meter were found near the mouth of the Oconto River. The population decreased to 500 per square meter 8 km from the mouth of the river. The area was dominated by bloodworms rather than sludgeworms. A few pollution-sensitive scuds existed less than two miles from its mouth.

A population of 800 organisms per square meter, mostly pollution-tolerant sludgeworms and bloodworms, was found near the mouth of the Peshtigo River. Near the mouth of the Menominee River, the population was 2,500 organisms per square meter. However, about 5 km out from the mouth of the river, a population of 1,300 per square meter of pollution-sensitive scuds was found. The concentrations of bottom fauna in the vicinity of the Menominee and Peshtigo Rivers is shown in Figure 24.

A summary of these data appears in Table 16.

TABLE 16. BENTHIC FAUNA POPULATIONS IN GREEN BAY, 1962-63

Location	Counts	Discussion
Fox River mouth	5,000-1,500/m^2	mostly sludgeworms or bloodworms
8 km from mouth	----	some pollution-sensitive scuds
16 km from mouth	500/m^2	mostly sludgeworms or bloodworms
Oconto River mouth	2,000-5,000/m^2	
3.2 km from mouth	----	a few pollution-sensitive scuds
8 km from mouth	500/m^2	dominated by bloodworms not sludgeworms
Mouth of Peshtigo River	800/m^2	mostly pollution-tolerant sludgeworms and bloodworms
Menominee River mouth	2,500/m^2	
5 km from mouth	1,300/m^2	pollution-sensitive scuds

Figure 23

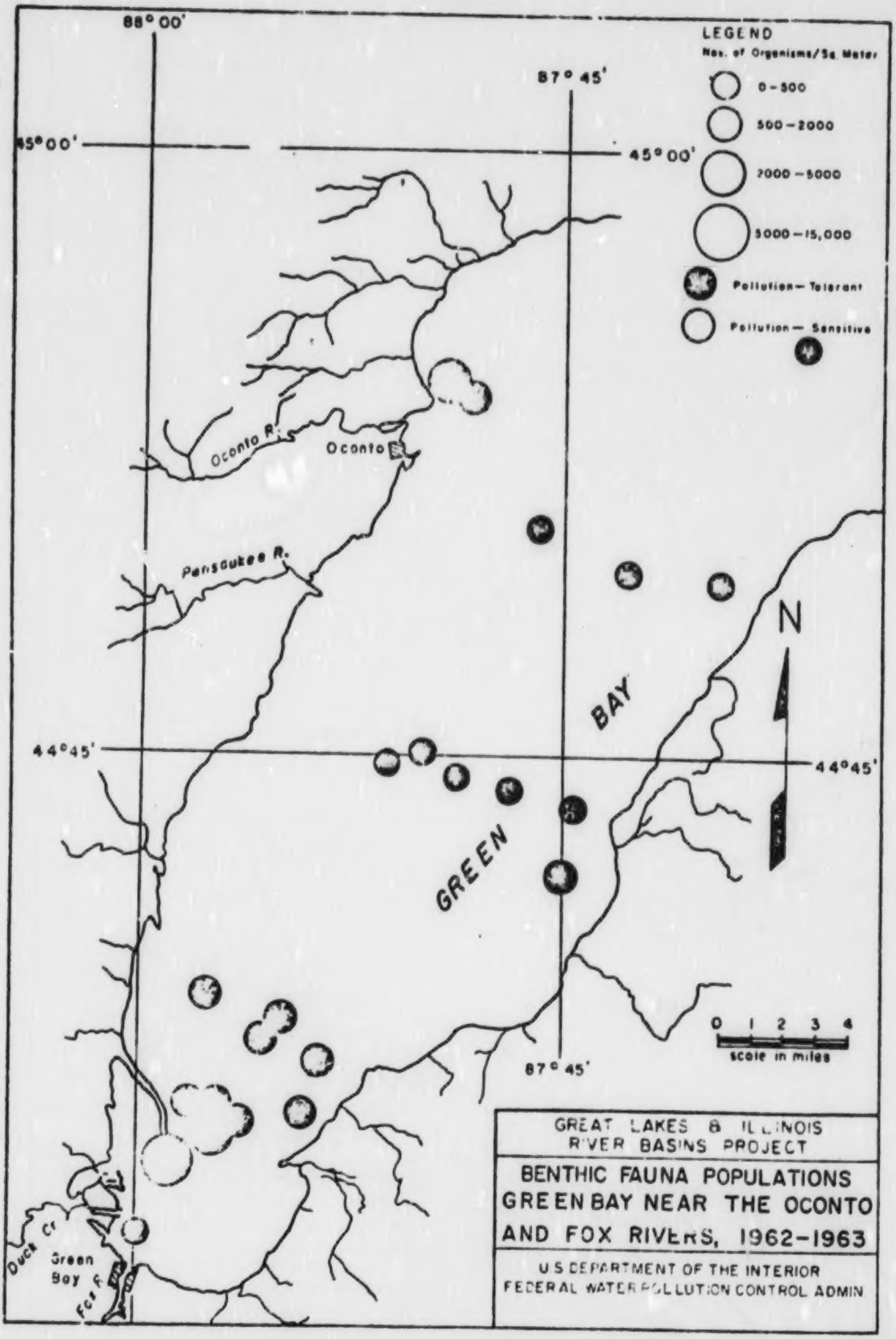
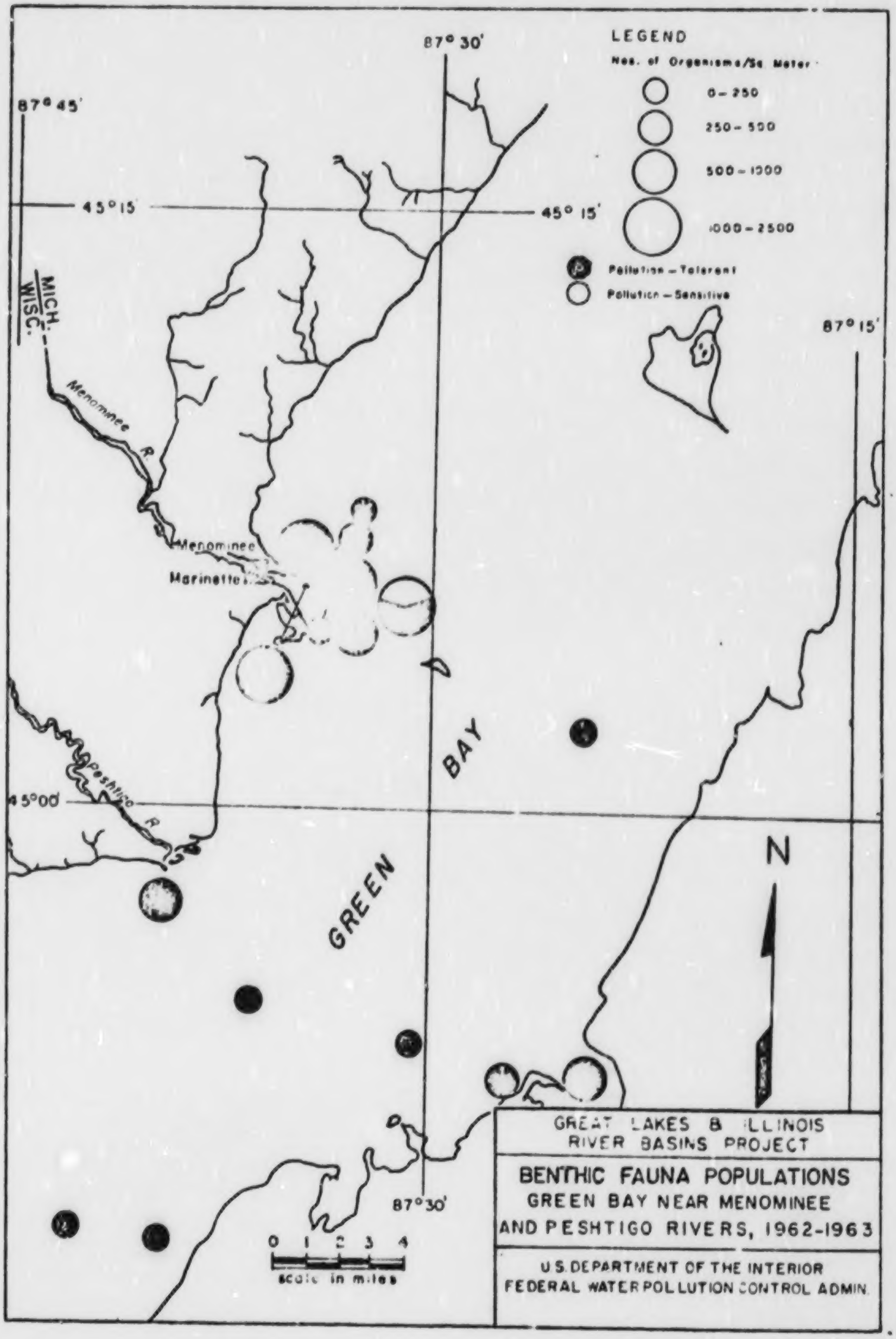

88° 00'
87° 45'
45° 00'
45° 00'
44°45'
44°45'
87° 45'
LEGEND
Nos. of Organisms/Sq. Meter
0-500
500-2000
2000-5000
5000-15,000
Pollution— Tolerant
Pollution— Sensitive
Oconto R.
Oconto
Pensaukee R.
GREEN BAY
N
0 1 2 3 4
scale in miles
Duck Cr
Green Bay
Fox R.
GREAT LAKES & ILLINOIS
RIVER BASINS PROJECT
BENTHIC FAUNA POPULATIONS
GREEN BAY NEAR THE OCONTO
AND FOX RIVERS, 1962-1963
U.S. DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMIN

Figure 24


LEGEND
Nos. of Organisms/Sq. Meter
0 - 250
250 - 500
500 - 1000
1000 - 2500
Pollution - Tolerant
Pollution - Sensitive
87° 30'
87° 45'
45° 15'
45° 15'
87° 15'
MICH.
WISC.
Menominee R.
Menominee
Marinette
Peshtigo R.
45° 00'
GREEN BAY
N
87° 30'
0 1 2 3 4
scale in miles
GREAT LAKES & ILLINOIS RIVER BASINS PROJECT
BENTHIC FAUNA POPULATIONS
GREEN BAY NEAR MENOMINEE AND PESHTIGO RIVERS, 1962-1963
U.S. DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMIN.

An extensive water quality investigation of Green Bay was carried out in 1966 and 1967 by the Wisconsin Department of Natural Resources (Schraufnagel et al, 1968). Bottom invertebrate organism populations were obtained during the investigation. The following observations were made:

1. Within 1.6 km of the channel in the Inner Bay (south of Long Tail Point) populations were depressed to the extent that no bottom organisms were observed. Between 2.4 and 3.2 km of the channel concentrations of 0 to 270 organisms per m^2 were noted. At 5 km east of the channel, the population was dominated by midgefly larvae and approximately 190 to 270 bottom macro-invertebrates per square meter were noted. In the intermediate vicinity of Long Tail Point, the bottom populations were dominated by sludgeworms, but the numbers were generally under 1,000 organisms per square meter. In the ship channel, two samples revealed 146 and 314 oligochaete worms per square meter.

2. Middle Green Bay (from the entry light north to Sturgeon Bay) had a bottom population dominated by sludgeworms but generally less than 1,600 per square meter. Midgefly larvae (Chironomus) were routinely observed but only about 220 organisms per m^2.

3. Outer Green Bay (Sturgeon Bay to Washington Island) began to reveal significant numbers of pollution intolerant species.

Schraufnagel et al (1968) concluded that only tolerant and very tolerant species dominate the macro-invertebrate population in lower and middle Green Bay. An important qualitative observation was made about nymphs of the pollution-sensitive burrowing mayfly (Hexagenia), commonly known as Green Bay fly, which had been an important part of the benthic community. The adults were once "known to gather under outdoor electric lights in the City of Green Bay, literally by the bushel on many summer evenings" (Wisconsin State Committee on Water Pollution, 1939). The nymphs were found in 31 percent of the samples in 1938-39, but in only one area in 1952. They were absent from samples in 1955 and 1966.

The most extensive survey to date of the Oligochaete fauna of Green Bay has been carried out by Howmiller and Beeton (1970). They sampled 103 stations between the City of Green Bay and Washington Island in 1966-67 and in 1969. Oligochaete worms have been the most abundant macro-invertebrates throughout lower and middle Green Bay in all studies since 1938-39. Howmiller and Beeton (1970) found that these animals comprised 60 percent of all invertebrates sorted from samples taken in the inner Bay and about 50 percent of the macro-invertebrate bottom fauna in the remainder of the Bay. Other invertebrate groups represented in the samples were, in order of abundance: midge larvae, amphipods, isopods, leeches, molluscs and mayfly nymphs.

Large numbers of tubificid Oligochaete worms have long been cited as evidence of pollution. Surber (1957) suggested that an abundance of tubificids in excess of 1,000 per square meter apparently truly represented polluted habitats. Wright (1955) and Carr and Hiltunen (1965) used the following numbers of Oligochaetes to designate pollution areas in western Lake Erie: light pollution, 100-999 per square meter; moderate pollution, 1,000-5,000; heavy pollution, more than 5,000. Howmiller and Beeton (1970) conclude that by these standards, lower Green Bay is heavily polluted. In addition, they find that, according to Wright's standards, the middle Bay was moderately polluted in 1969.

Howmiller and Beeton (1970) have pointed out that little is known of the seasonal dynamics of Oligochaete populations. They showed that the population of the lower Bay decreased sharply at the same stations between October, 1966 and May, 1967. They attributed this decrease to depleted oxygen conditions which occurred over much of this area during the winter months. Howmiller and Beeton (1971) have criticized the conclusions, drawn from the 1955 survey, that there had been a reduction in the number of pollution tolerant benthic animals in the period since the surveys of 1938 and 1952. The survey in January, 1955 may have been taken during a seasonal period of reduced population.

Howmiller and Beeton (1971) have examined earlier data in an attempt to compare current bottom conditions with earlier conditions. They concluded that critical comparison with past studies is difficult because (a) measurements were seldom made at the same stations, (b) the measurements were not made at the same season of the year, and (c) different apparatus and methodology were used. Prior to the mid-sixties, few investigators attempted to identify worms as to species or even genera. In an attempt to eliminate these sources of inaccuracy, the benthos of 27 stations of lower and middle Green Bay were sampled on May 26, 1969. The same stations had been sampled in a similar way on May 26-27, 1952 by Surber and Cooley (1952).

Table 17 reports the changes which have occurred in the lower and middle portions of Green Bay between 1952 and 1969 (Howmiller and Beeton, 1971).

TABLE 17. PERCENTAGE OF OLIGOCHAETE IN THE BOTTOM FAUNA OF GREEN BAY, 1952 AND 1969

	1952	1969
Lower Bay (south of entrance light)	66%	85%
Middle Bay (entrance light to Sturgeon Bay)	23%	64%

Goodnight and Whitley (1960) proposed that the relative abundance of Oligochaete worms in the benthos should be used as an index of pollution. A good condition existed if the bottom fauna were less than 60 percent Oligochaete, "doubtful" if 60-80 percent, and high polluted if more than 80 percent Oligochaetes. According to these standards, the Lower Bay has deteriorated from a doubtful condition to a highly polluted state in the intervening seventeen years. The Middle Bay has gone from a "good condition" to a "doubtful" one since 1952.

The aquatic larvae of midges (Chironomidae) were the second most abundant and widespread members of the benthic fauna in both 1952 and 1969. The Chironomidae includes many species which are adapted to a wide range of environmental conditions. As a group, they display pollution tolerance second only to the Oligochaete. Like many Oligochaete, the pollution tolerant midges have an abundant supply of hemoglobin which makes them very efficient at obtaining oxygen at the low concentrations associated with organic pollution. The midges decreased markedly in the vicinity of the Fox River mouth. Increased numbers were found at stations north of Long Tail Point. This increase was not as great as the increase in Oligochaete with the result that the midges decreased in relative importance from an average of 48 percent in 1952 to 37 percent in 1969 in the middle Bay and from 37 to 26 percent for the entire Bay.

Howmiller and Beeton (1971) have summarized their results for the various species in lower Green Bay for which comparison can be made with the earlier study by Surber and Cooley (1952). Pollution intolerant species are included in these comparisons. These results appear in Figure 25 and are summarized in Table 18.

Howmiller and Beeton (1970, 1971) conclude that if pollution of the Bay, via the Fox River, continues:

1. The dominant species will, to an increasing extent, be associated with gross pollution;

2. A larger abiotic area around the river mouth can be expected, since conditions have become unsuitable for even the pollution tolerant organisms;

3. Midge larvae would be expected to decrease in abundance at stations farther north in the lower Bay;

4. The Oligochaete, the only group which increased in absolute and relative abundance between 1952 and 1969, would become even more important in the benthic community. Most others have declined. The zone of maximum abundance will be found farther out into the Bay from the mouth of the Fox River.

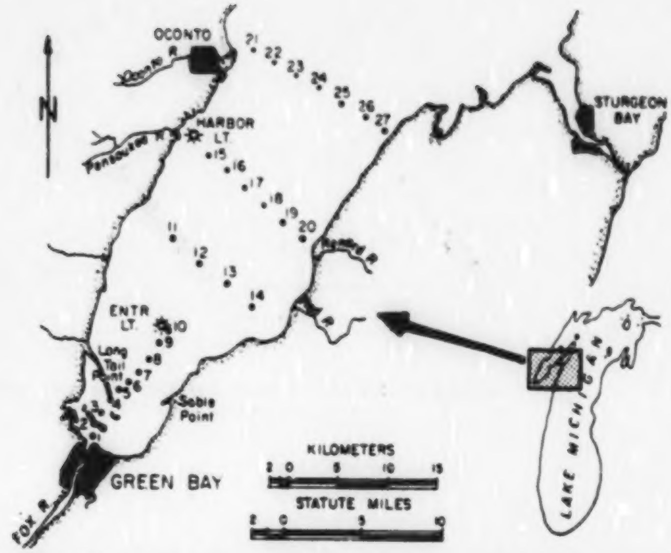


FIGURE 25a–Lower and middle Green Bay, Lake Michigan, showing bottom sampling stations of 26 and 28 May 1952 and 26 May 1969.

Howmiller and Beeton (1971)

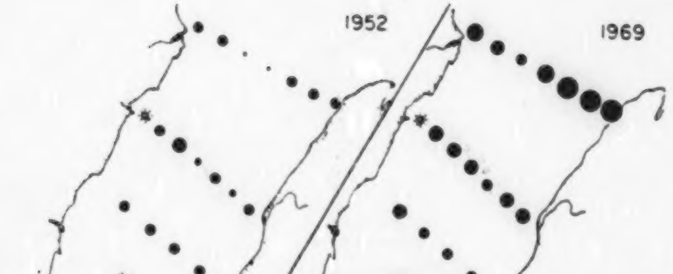


FIGURE 25b.-Distribution and abundance of Oligochaeta in the sediments of lower and middle Green Bay on 26 and 28 May 1952 (left), and 26 May 1969 (right).

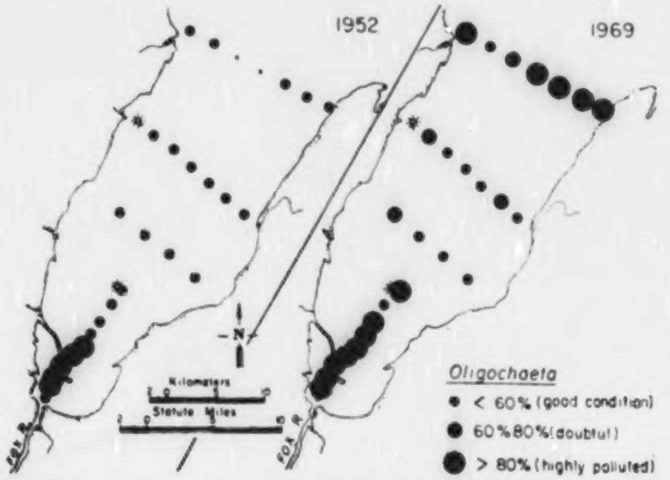


FIGURE 25c.-Relative abundance of Oligochaeta, as percentage of total bottom fauna, in May 1952 and 1969.

Howmiller and Beeton (1971)

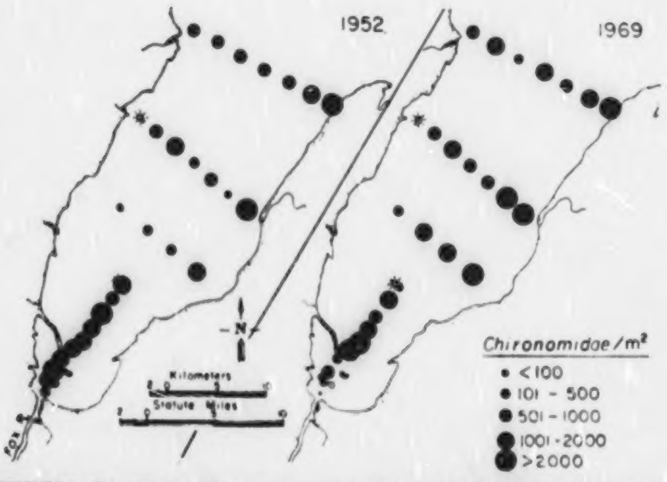


FIGURE 25d. Distribution and abundance of Chironomidae in May 1952 and 1969.

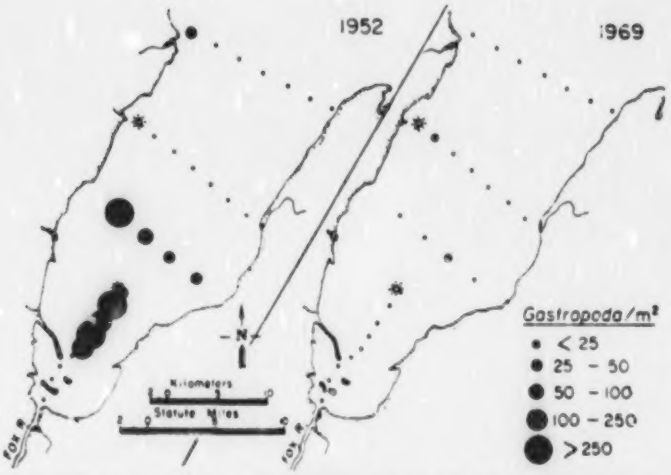


FIGURE 25e.-Distribution and abundance of snails in May 1952 and 1969.

Howmiller and Beeton (1971)

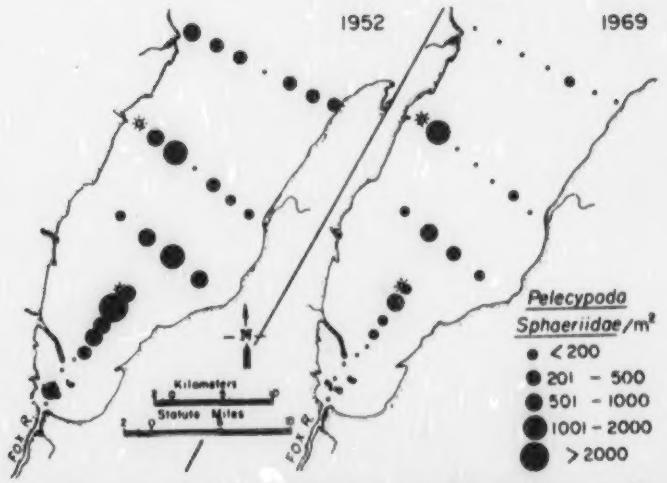


FIGURE 25f.-Distribution and abundance of fingernail clams in May 1952 and 1969.

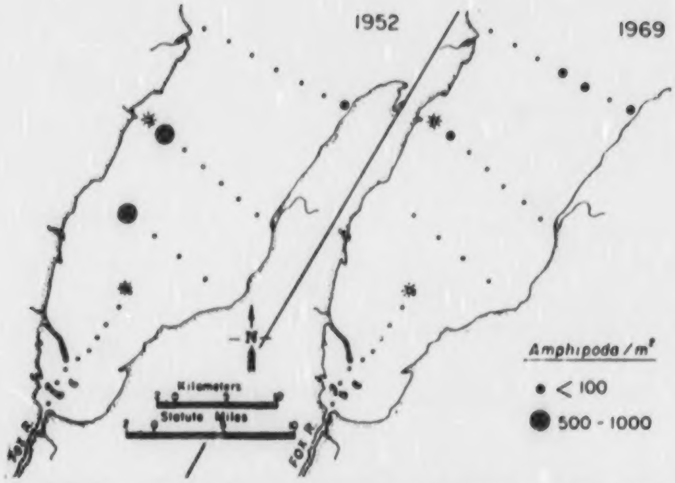


FIGURE 25g.-Distribution and abundance of amphipods in May 1952 and 1969.

Howmiller and Beeton (1971)

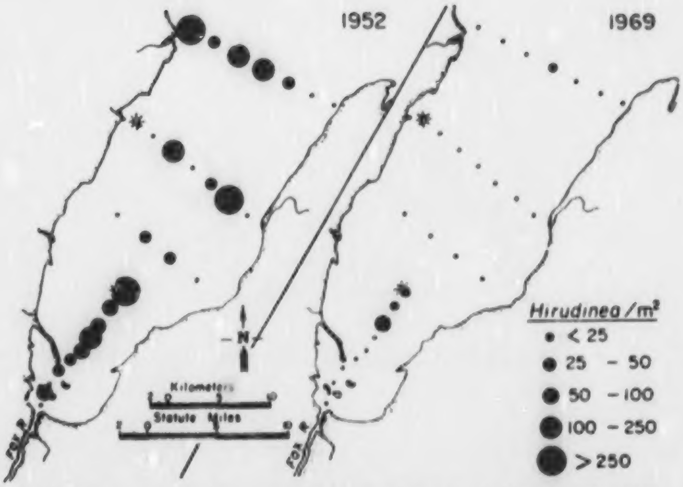


FIGURE 25h.-Distribution and abundance of leeches in lower and middle Green Bay in May 1952 and 1969.

Summary of Data in Figure 25

Table 18 —**Abundance of Benthic Invertebrates at Stations Shown in *Figure* 25a on 26 and 27 May 1952***

Station	Abundance of Given Invertebrate (no./sq m)								
	Nematoda	Oligochaete	Leeches	Snails	Clams	Amphipods	Isopods	Midges	Other
1	0	43	0	0	0	0	0	129	43 *Eristalis*
2	0	113,152	86	0	258	0	0	1,377	
3	0	33,829	0	0	0	0	0	3,099	
4	0	51,175	43	0	0	0	0	1,636	
5	0	13,472	43	0	0	0	43	1,679	
6	0	9,813	86	172	344	0	0	1,765	
7	0	2,109	215	258	732	0	0	1,679	
8	0	1,420	86	129	732	0	0	2,281	
9	0	2,324	86	301	2,668	0	0	947	
10	0	775	258	43	516	0	0	1,162	
11	0	897	0	258	75	710	11	86	11 Caddis, *Molanna*
12	0	430	43	86	516	0	0	344	
13	0	258	43	43	1,592	0	0	258	
14	0	904	0	43	603	0	0	1,519	
15	0	603	0	0	732	560	301	990	
16	43	1,033	129	0	1,420	0	0	1,334	
17	0	86	0	0	0	0	0	301	
18	0	387	43	0	301	0	0	646	
19	0	43	344	0	43	0	0	86	
20	0	581	0	0	129	0	0	2,539	
21	0	861	258	43	603	0	0	646	
22	0	818	43	0	473	0	0	775	
23	0	0	129	0	301	0	0	646	
24	0	0	129	0	0	0	0	818	
25	0	301	43	0	387	0	0	560	
26	0	387	0	0	301	0	0	1,291	
27	0	516	0	0	258	43	0	2,410	

* Data of Surber and Cooley

—Abundance of Benthic Invertebrates at Stations shown in Figure 25a on 26 May 1969

Station	Abundance of Given Invertebrate (no./sq m)								
	Nematoda*	Oligochaeta	Leeches	Snails	Clams	Amphipods	Isopods	Midges	Other
1	0	0	0	0	0	0	0	0	96 *Psychoda*
2	+	22,657	0	0	0	0	0	38	
3	0	8,604	0(114)†	0	0	0	0	688	
4	+	7,227	0	0	0	0	0	440	
5	+	29,292	0	0	0	0	0	2,237	
6	+	16,921	0	0	0	0	0	3,155	
7	+	11,854	76	0	38	0(19)†	0	1,778	
8	+	4,264	0(133)†	0	57	0	0	860	
9	+	2,008	19	0	631	0	0	1,759	
10	+	1,032	19	0	19	0	0	76	
11	+	1,663	0	0(38)†	172	0(38)†	0(19)†	402	
12	+	822	0	0	994	0	0	1,836	
13	+	688	0	19	268	0	0	1,644	
14	+	918	0	0	19	0	0	3,097	
15	+	2,792	0	19	1,166	19	0	554	19 *Lampsilis*
16	+	1,281	0	0	0	0	0	1,128	
17	+	1,109	0(38)†	0	0(19)†	0	0	918	
18	+	229	0	0	0	0	0	707	
19	+	4,531	0	0	57	0	0	2,314	
20	+	2,658	0	0	0	0	0	2,065	
21	+	5,354	0	0	0	0	0	803	
22	+	1,740	0	0	0	0	0	1,530	
23	+	899	0	0	0	0	0	344	
24	+	9,770	19	0	0	57	76	1,300	
25	+	10,325	0	0	10	38	38	631	
26	+	23,441	0	0	0	0	0	1,166	
27	+	10,095	0	0	0	19	0	2,275	

* Nematoda were very numerous in many samples but certainly not sampled quantitatively, hence not counted.

† Not taken in Ekman grab sample but numbers of animals in parentheses were recorded from Ponar grab sample taken at the same time.

DISSOLVED OXYGEN

Measurements of dissolved oxygen concentrations have been a significant part of Green Bay surveys since 1939 (Wisconsin State Committee on Water Pollution, 1939; Surber and Cooley, 1952; Balch et al, 1956; Schraufnagel et al, 1968; Sager, 1971). The dissolved oxygen content of lower Green Bay depends upon the condition of Fox River water as it reaches the Bay. The temperature, flow rate and dissolved oxygen levels in the Fox River vary considerably with the season of the year. This seasonal fluctuation is the most significant factor which influences the condition of Fox River water as it enters Green Bay. The relative importance of the Fox River in relation to other tributaries of Green Bay has been discussed earlier. (See Table 11).

The discharge of decomposable organic wastes to a confined body of water results in the development of a degree of pollution dependent upon the oxygen requirements of these wastes and the amount of dissolved oxygen availabe in the receiving waters. Where the load of organic wastes exceeds the self-purification capacity of the stream, critical and zero dissolved oxygen concentrations develop at downstream locations.

Biochemical oxygen demand (BOD) measures the amount of oxygen utilized by decomposing organic matter. The relationship between the biochemical oxygen demand and dissolved oxygen is controlled by temperature, time, reaeration rate, and concentration. When the water temperature increases, the dissolved oxygen concentration at saturation decreases and the organic decomposition rate increases. Under these warmwater conditions, the point of low dissolved oxygen will be found near the point of waste discharge. Conversely, with cold temperatures, the zone of low dissolved oxygen is farther downstream from the waste source. Critical oxygen conditions are least likely to occur in open stream waters with the temperature just above the freezing point because of the higher saturation dissolved oxygen concentrations, low decomposition rates and improved reaeration capacity. With ice cover, much of a stream's reaeration capacity is lost and critical conditions can develop at substantial distances from the waste source.

Dissolved oxygen concentrations were measured extensively during a survey conducted in 1938-39 (Wisconsin State Committee on Water Pollution, 1939). This survey consisted of a series of stations extending northward for 37 km and covered the period from November, 1938 until June, 1939. In November, before ice cover had formed, the dissolved oxygen content was high, varying between 85 and 100 percent of saturation for all samples. The lowest values occurred in waters closest to the mouth of the Fox River. After safe ice had formed, dissolved oxygen samples were obtained within the inner Bay, directly off Point Sable, and at Dyckesville. These samples showed that the waters in the inner Bay were generally at 85 percent saturation, the waters off Point Sable at 30 percent saturation, and the waters at Dyckesville at 90 percent saturation. In February and March, 1939, a series of measurements were made on a weekly basis at more than fifty stations in order to assess the effect of ice cover on dissolved oxygen content and to define the extent and direction of travel of this water low in dissolved oxygen. The results of these measurements were interpreted to indicate that oxygen depletion occurred throughout the period of ice cover. The oxygen depletion was divided into three zones: (1) the zone of deoxygenation, (2) the zone of maximum oxygen depletion, and (3) the zone of recovery. A zone of deoxygenation extended from the mouth of the Fox River to Point Sable; from there a zone of maximum oxygen depletion existed along the east shore for varying distances, increasing in length but not width as the period of ice cover increased. The investigators suggested that the zone of maximum oxygen depletion was occasionally divided into two zones by the introduction of unpolluted water high in oxygen content from the western portion of the Bay. The points where this water was introduced were considered as local zones of recovery where the polluted and unpolluted waters merged. As long as ice cover remained, this zone of recovery receded further and further towards the north.

Data from the late spring months of 1939 indicated that the zone of deoxygenation was located within that portion of the Fox River below the sulfite mills in the City of Green Bay and the zone of maximum oxygen depletion existed within the inner Bay (south of the Long Tail Point--Point Sable line). The zone of recovery caused by reaeration and mixing existed immediately outside the inner Bay. Differences in oxygen demand between summer and winter were ascribed to increased rates of oxygen uptake at the higher temperatures. The workers in 1939 discarded the theory that bottom conditions might be the cause of the areas of low dissolved oxygen content in both winter and summer. They found that the oxygen content in winter at the mouth of the Fox River was always high, a point where bottom conditions were poorest in terms of oxygen demand. Maximum oxygen depletion took place near Point Sable where the water depth was 9.2 meters.

Measurements of biochemical oxygen demand (BOD) accompanied measurements of dissolved oxygen. Under winter conditions, water at the mouth of the Fox River had a high (10-12 ppm) BOD. From this point, the BOD fell rapidly to a low of about 2 ppm near Point Sable and remained constant northward throughout the central and eastern portions of the Bay. In May, 1939, BOD at the mouth of the river was approximately 5 ppm. This value remained the same to a point approximately in the middle of the inner Bay (along the ship channel) and then dropped to 3 ppm within approximately one-half mile of this point and remained fairly constant at this value through the remainder of the

Bay as far north as Dyckesville. These values were more erratic in their distribution than those noted under winter conditions, probably because of mixing from wind action. The BOD and dissolved oxygen measurements for the spring of 1939 are summarized in Appendix IX.

The investigators in 1939 attributed the relationship between dissolved oxygen depletion and biochemical oxygen demand in Green Bay to the waste sulfite liquor in the Fox River water. The differences between winter and summer conditions were ascribed to differences in the rate of the biochemical oxygen demand of the sulfite liquor at high and low temperature.

Dissolved oxygen concentrations in lower Green Bay were measured extensively from the summer of 1955 until March, 1956 (Balch et al, 1956). It was found that from the middle of June until the middle of August, the region south of the Grassy Islands was generally deficient in oxygen (4 to 19 percent saturation, corresponding to dissolved oxygen values of 0.3 to 1.7 ppm). In this same region, the BOD was high (a variation of 15.5 to 24.0 ppm). These results contrasted with the 1938-39 survey which revealed dissolved oxygen values no lower than 2-3 mg/l during all periods when there was no ice cover. No BOD values in 1938-39 reached the levels found in the 1955-56 study.

In the summer of 1955, the region north of the Grassy Islands and south of the Long Tail Point--Point Sable line showed a great deal of variation in dissolved oxygen concentration. On two occasions, samples in this region contained no dissolved oxygen. The BOD here ranged from 11.5 to 26.5 ppm. Most of the other samples had concentrations corresponding to 50 to 80 percent saturation and had a biochemical oxygen demand of 4 to 9 ppm. The remainder of the measurements throughout Green Bay during the summer of 1955 were described as normal in both dissolved oxygen and in BOD content.

Measurements were made during the period of ice cover in February, 1955 (Balch et al, 1956). Although the data was regarded as inadequate for a comprehensive understanding of the conditions obtained beneath the ice on Green Bay, they were used to give a general indication of winter conditions. A "generally reduced dissolved oxygen content" south of an east-west line from the tip of Long Tail Point to Sable Point. Various analyses for dissolved oxygen within this area ranged from 0.1 ppm to 2.0 ppm. The higher value was noted in the vicinity of the mouth of the Fox River. On the east shore of Green Bay, north of Point Sable to a point approximately midway between Point Sable and Point Comfort, a series of samples taken on February 16, 1955 indicated water that varied from a trace to 6.6 ppm in dissolved oxygen. The higher readings were close to shore. Approximately one mile from shore in water over 20 feet deep, there was no measureable dissolved oxygen.

Samples taken in surveys during late January and early March, 1956, indicated a different condition than that present under the ice in February, 1955. On the east shore of the Bay, dissolved oxygen in the vicinity of Point Sable was about 0.2 ppm on top and 0.0 ppm on the bottom. BOD in this vicinity varied from 7.1 to 11.6 ppm. In the vicinity of Point Comfort, the dissolved oxygen on the bottom ranged from 0.1 to 0.3 ppm, but the surface waters contained as much as 15.0 ppm. Near Dyckesville, there appeared to be some indication of oxygen depleted water as one station contained 0.1 ppm dissolved oxygen on the bottom. On March 6, 1956, the oxygen content of the water in the vicinity of Dyckesville at several stations close to shore was less than 0.5 ppm. In general, reduced oxygen was noted 15 miles farther north in 1956 than in 1955 at the same time of year. The data from the 1955/1956 survey appears in Appendix X.

The survey in 1966-67 by Schraufnagel et al (1968) measured dissolved oxygen extensively under both winter ans summer conditions. Data from February 9-11, 1966 (Table 19) showed that decomposition of discharge wastes from the Fox River affected dissolved oxygen values for distances of 6 and 8 km from the river mouth. The discharges of the Fox River during the winter months normally revealed variable but nevertheless sufficient oxygen levels to sustain fish life. Observed values in the river were typically between 6 and 12 mg/l at this time. At the same time, samples taken at stations on the west side of the bay at a distance of 29 km from the mouth of the Fox River (designated as Middle Bay) did not show any appreciable dissolved oxygen reduction during this period except in the immediate vicinity of the mouth of the Oconto River (Table 19). Samples on the east side of Middle Green Bay indicated that although ice cover had been of only four weeks' duration, the dissolved oxygen had been substantially reduced near the bottom in the vicinity of Dyckesville (24 km from the mouth of the Fox River), but at Kohl's Landing (40 km) no depletion of dissolved oxygen in the bottom could be observed (Table 19).

TABLE 19. D.O. CONCENTRATION INNER BAY AREA
February 9 & 10, 1966

	Station Number*	Water Depth (M)	Sample Depth (M)	D.O. mg/l
Mouth of Fox River to Sable Point	1	1½	1	13.1
	2	3	2½	3.9
	3	2	1½	6.2
	4	2	1½	6.1
	5	2	1½	5.8
	6	2	1½	10.0
	7	3	1½	8.3
	8	3	2	5.5
In Long Tail Point Bay	9	2	1½	5.8
	10	2	1½	9.4
	11	3	2	8.8
	12	2	1½	5.7
	13	2	1½	6.8

*For station location, see Figure 26.

TABLE 19 (Continued)

	Station Number*	Water Depth (M)	Sample Depth (M)	D.O. mg/1
In Little Tail Point Bay	14	2	1½	14.9
	15	3	1½	15.1
	16	1½	1	12.4
	17	1½	1	14.5
South of Pensaukee	18	½	½	15.4
	19	4	Surface	14.7
			3	15.2
	20	7	Surface	14.3
			3	14.4
			6	14.9
Oconto River Area	21	6	Surface	8.6
			5	11.3
	22	6	Surface	14.5
			3	4.5
			6	6.8
	23	7½	Surface	14.0
			4	14.0
			7	11.6
Dyckesville	27	4½	Surface	14.3
			4	6.2
	28	7	Surface	4.2
			3	14.4
			6	14.2
	29	8	Surface	14.1
			3	13.9
			7	4.7
	30	8	Surface	13.7
			3	13.8
			7	5.3
	31	8½	Surface	14.0
			5	13.6
			8	5.4
	24	11	Surface	13.0
			4	12.8
			7	13.0
			10	11.6
	25	14	Surface	13.4
			4	13.5
			7	12.3
			10	12.7
			13	13.5
	26	15	Surface	13.0
			4	12.8
			9	13.0
			14	11.0

*For station location, see Figure 26.

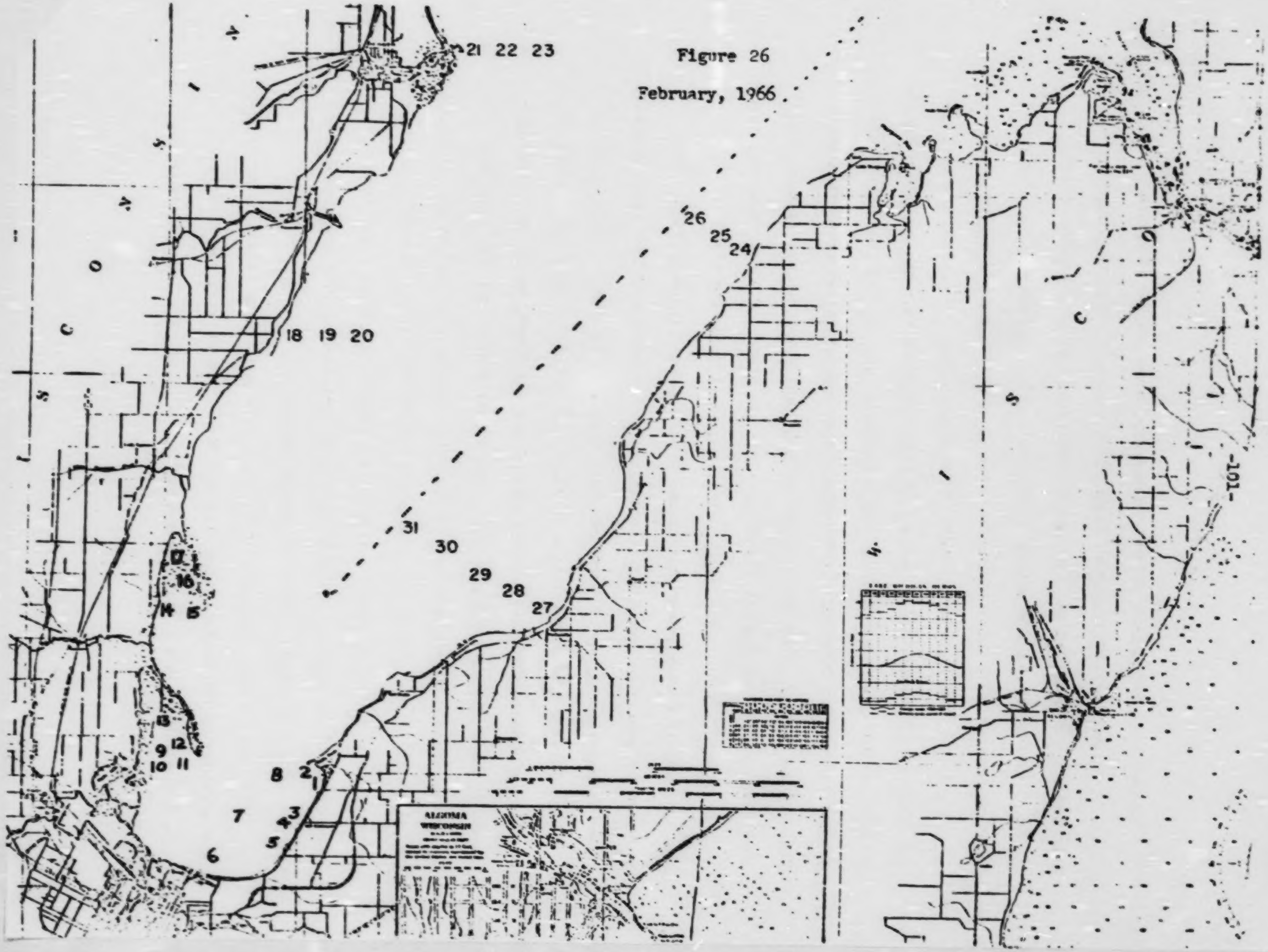


Figure 26

February, 1966

On March 10, 1966, just before ice breakup, more samples were taken (Table 20). Dissolved oxygen concentrations at Sable Point remained relatively high during this period. At Dyckesville, the oxygen conditions had deteriorated with a 0.5 mg/l observation at the bottom 0.4 km off shore. In general, ice conditions in the winter of 1966 were similar to those in 1939. Dissolved oxygen levels were found to be similar in the Sable Point area in the two years. However, in the vicinity of Dyckesville, limited sampling suggested that the dissolved oxygen concentrations were lower than in 1939, especially near the bottom. The region of the inner Bay in 1966 had consistently lower concentrations of DO than did this region in 1939. The region north of Long Tail Point is less amenable to comparison because of the paucity of data for the winter of 1966. However, there were stations in 1966 in the region about Long Tail Point which had DO concentrations significantly lower than values found in this region in 1939. The judgment is made here that DO concentrations in the winter of 1966 were generally lower in several regions of Green Bay than they were in 1939.

Extensive measurements were made during the summer of 1966 (see Figure 19). Monitoring stations in Zone A (the mouth of the Fox River, Mason Street Bridge) revealed ample dissolved oxygen during the winter months, but low dissolved oxygen during the summer months. On April 6, the dissolved oxygen was 12.0 mg/l at the surface. By July 5, the concentration had fallen to 2.8 mg/l. On August 12, no dissolved oxygen could be detected in the river. Gas bubbles were observed and hydrogen sulfide odors were pronounced. The low dissolved oxygen values generally prevailed through October 20.

The area between the mouth of the Fox River and Grassy Island (Zone B) was affected by the waste load of the Fox River. On July 5, the dissolved oxygen concentration was still over 4 mg/l. On August 12, the dissolved oxygen in this region was less than 1 mg/l. This condition persisted through September 7, but by October 20 the dissolved oxygen was over 4 mg/l at Grassy Island.

The zone (Zone C) just east of the ship channel to the east shore and extending approximately 0.8 km from the shore was defined distinctly because of wind blown algae accumulations and wave action along the shore. The effect of zero detectable oxygen in the Fox River discharge during the summer was noted in this region. For a distance of 2.4 km east of the channel, no oxygen was detected. Three point two (3.2) km east of the channel, the dissolved oxygen concentration was 4.1 mg/l and at 4.0 km, the dissolved oxygen concentration was variable but probably in the vicinity of 6 mg/l. On October 20, when the river was still discharging water devoid of dissolved oxygen, the station east of the channel was still less than 1 mg/l, while at 3.2 km, the concentration was approximately 3 mg/l.

TABLE 20. D.O. CONCENTRATIONS ON INNER BAY AREA
March 10, 1966

	Station Number*	Water Depth (M)	Sample Depth (M)	D.O. mg/l
Sable Point	1	2	1½	9.6
	3	2½	2	8.7
	4	2	1½	8.8
	4A	2	1½	2.2
Long Tail Point	10	2	1½	10.3
	11	2	1½	10.5
	12	2	1½	10.1
	13	2	1½	10.5
Little Tail Point	14	1	½	13.2
	15	2	1½	10.6
Dyckesville	27	4	Surface	10.0
			3½	0.5

*For station location, see Figure 27.

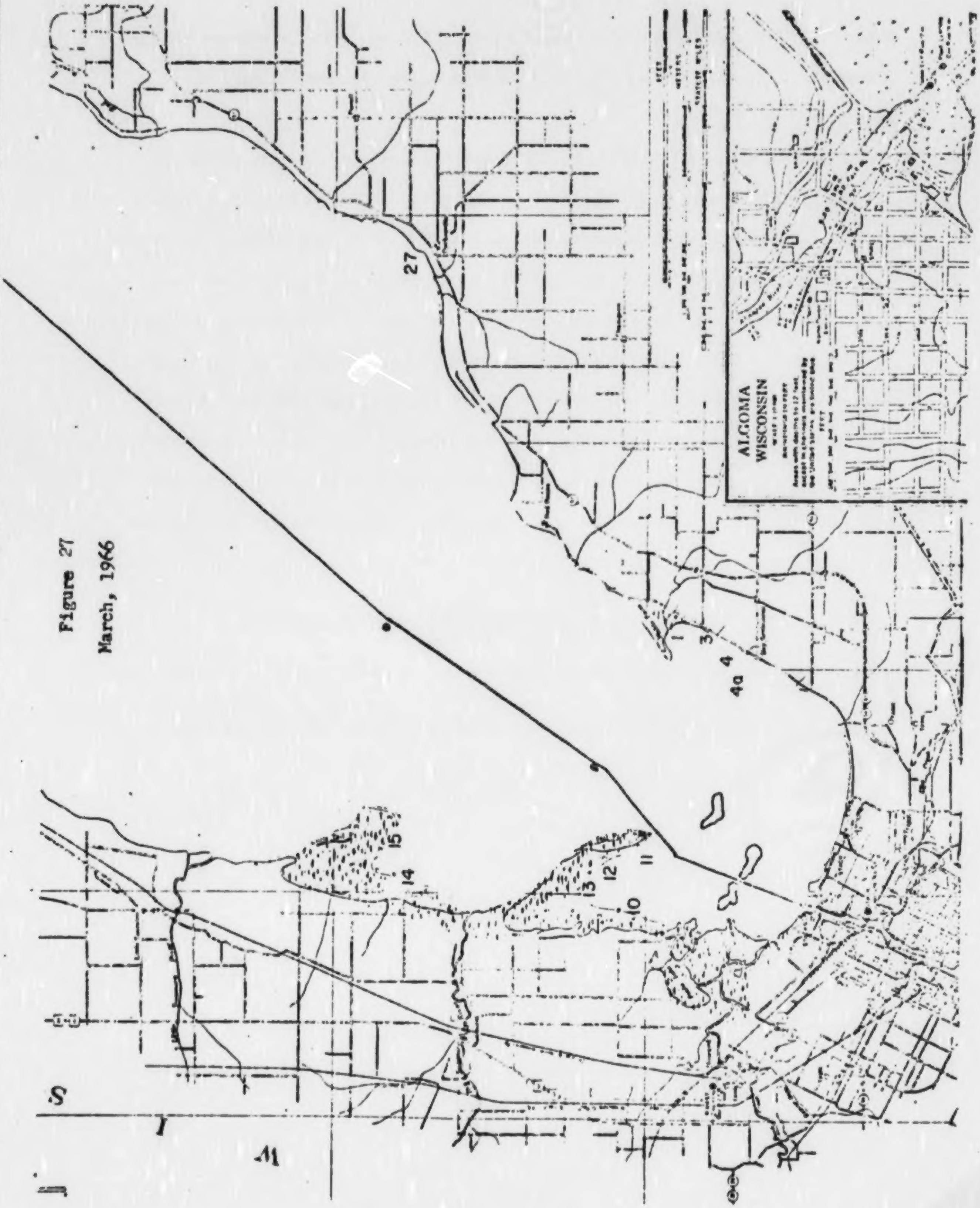


Figure 27

March, 1966

The remaining portion of the Bay below Long Tail Point and east of the ship channel (Zone D) was found to contain a concentration of dissolved oxygen sufficient to sustain fish and fish food organisms. Only one sample in the channel, halfway between Grassy Island and Long Tail Point, revealed less than 2 mg/l dissolved oxygen. The other samples revealed concentrations greater than 4 mg/l throughout the summer months. This represented some depletion due to waste stabilization since without wastes saturated values of 8 to 10 mg/l dissolved oxygen would be expected.

The west side of the Bay below Long Tail Point (Zone E) showed dissolved oxygen values that appeared to be free of the influence of wastes.

The region north of Long Tail Point and extending to Sturgeon Bay (Zones G and F), as well as the region from Sturgeon Bay to Washington Island, showed no effects from the waste discharges of tributary streams during the summer of 1967.

In early February, 1967, the ice cover in lower Green Bay exceeded 0.4 meters (20 inches). On February 8, the dissolved oxygen concentration within three miles of the Fox River mouth was sufficient to sustain fish and fish food organisms. However, at a distance 6.4 km from the mouth of the Fox River and east of the ship channel (Sable Point area), the dissolved oxygen concentration was less than 0.5 mg/l (Table 21).

TABLE 21. D.O. CONCENTRATION IN LOWER GREEN BAY
February 8-10, 1967

Field Station	Map Station*	Surface	D.O. Mid Depth	Bottom	Miles from Mouth of Fox
1	1	6.6	-	6.2	2
2	2	6.6	-	5.6	2½
3	3	4.0	-	-	3
4	4	8.3	-	-	1½
5	5	0.2	-	0.1	5
6	6	0.5	-	0.3	4½
7	7	0.3	-	0.1	4
8	8	0.2	-	0.1	5½
February 10, 1967					
4	9	0.0	0.0	0.0	8-9
5	10	0.9	0.0	0.0	8-9
6	11	2.8	0.7	0.0	8-9
7	12	7.3	3.4	0.1	8-9
8	13	10.1	9.0	0.1	8-9
9	14	11.1	9.7	1.7	8-9
10	15	7.5	1.9	5.5	8-9
11	16	9.5	8.8	0.8	9-10
12	17	11.1	10.9	0.6	9-10
13	18	9.1	8.2	10.8	9-10
14	19	8.8	5.3	0.7	9-10
15	20	6.7	4.5	0.5	9-10
16	21	0.4	0.0	0.1	9-10
				0.0	

*For station location, see Figure 28.

Dissolved oxygen concentration near the shore north of Sable Point was essentially zero. Concentration increased along the ship channel where values were probably not influenced by waste stabilization (Table 22).

The area east of the harbor light and extending toward the shore revealed no dissolved oxygen at the bottom and only 2 to 3 mg/l at the surface. Proceeding west, north or east, the dissolved oxygen condition tended to improve, exceeding 5 mg/l at all surface sites. The bottom concentrations were significantly reduced (less than 3 mg/l) out to approximately 26 km. Beyond this distance,

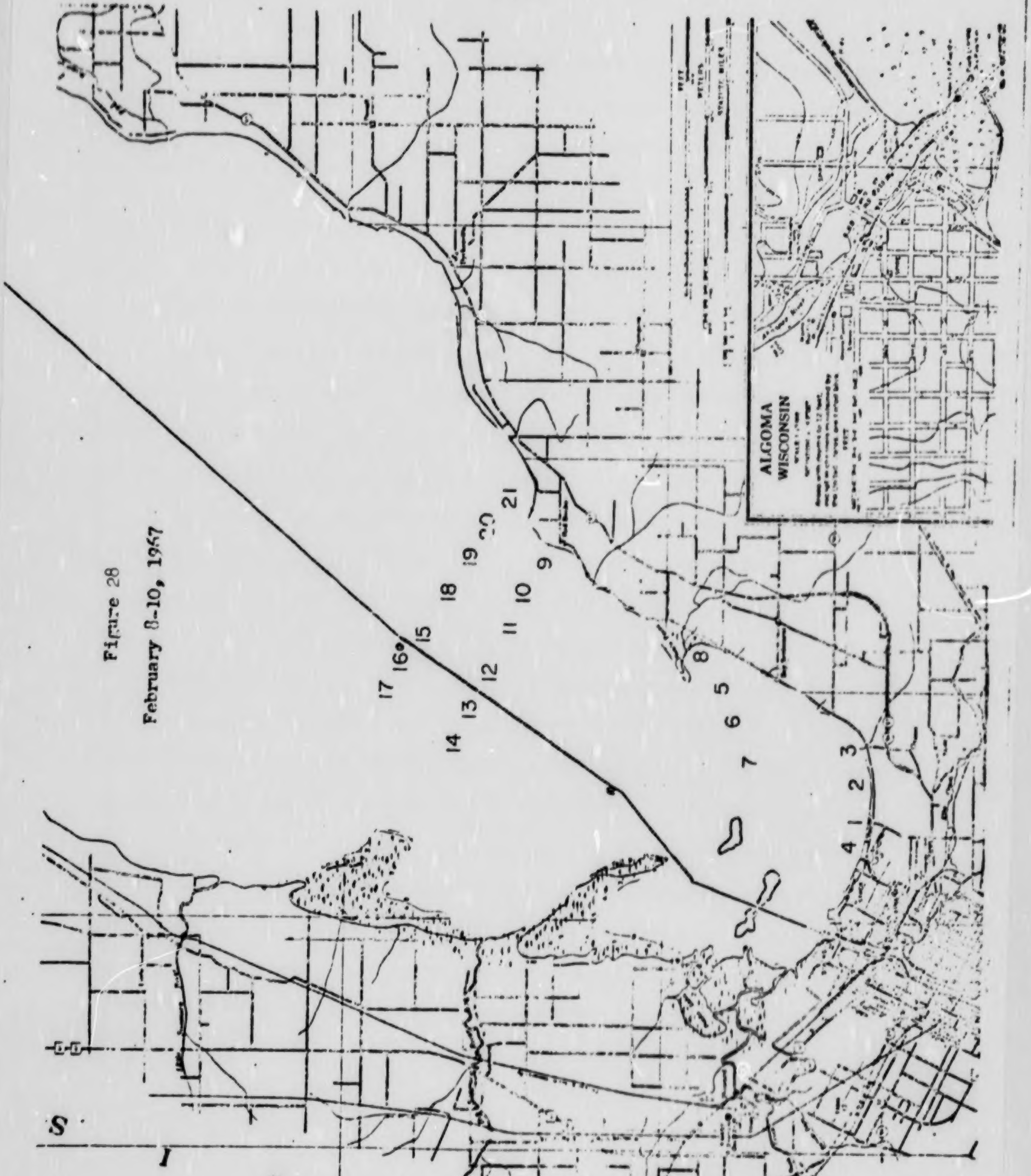


Figure 28

February 8-10, 1967

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there was no depletion in dissolved oxygen on February 9. Commercial fishermen during this period had been forced to move nets from sites that were recording less than 1 mg/l at the bottom and were having no difficulty in areas recording the higher values.

In order to determine how far the front of low dissolved oxygenated water had proceeded, the region from Dyckesville to Sturgeon Bay was surveyed again in March. By March 9, the commercial fishermen had abandoned the Dyckesville area as a site of net fishing. The dissolved oxygen concentrations were not as low as were observed a month earlier. Stations 2, 3 and 4 (Table 23) which had previously recorded dissolved oxygen values of less than 1 mg/l, revealed values of no less than 2 mg/l. However, stations 10, 12 and 13, which were approximately 29 km from the mouth of the Fox River and which revealed no apparent oxygen depletion in February, had less than 1 mg/l on March 9. Stations 27 and 28 (43 km from the mouth of the Fox River) also had less than 1 mg/l dissolved oxygen near the bottom. In this region, fishermen were taking dead fish out of one end of their nets while 800 feet away at the other end they were taking live fish. The dissolved oxygen concentrations at these points were 0.1 and 9.9 mg/l, respectively. These observations were suggestive of the magnitude of the oxygen depletion and of the sharp gradients in oxygen concentrations that can be detected miles from the source of wastes.

A final series of dissolved oxygen measurements were made on March 23, 1967 at stations 40-43 km from the mouth of the Fox River. Low concentrations of dissolved oxygen were found in almost all bottom waters between the channel and 0.8 km from the east shore. Surface waters retained an adequate dissolved oxygen concentration to sustain fish life.

A comparison of D.O. concentrations in the winters of 1939 and 1967 in Green Bay shows that concentrations in the inner Bay (south of Long Tail Point) were substantially lower in 1967 than in 1939. The concentrations in the region above Long Tail Point and along the eastern shore were consistently lower in 1967 than in 1939.

TABLE 22. D.O. CONCENTRATIONS IN MIDDLE GREEN BAY (DYCKESVILLE AREA)
February 9, 1967

Station Number*	Surface	Mid Depth	Bottom	Miles from Mouth of Fox
1	12.2	-	2.7	14½
2	11.2	10.3	2.3	14
3	11.4	9.5	1.4	13½
4	10.5	10.4	1.5	13
5	7.8	6.1	0.5	12½
6	5.6	1.0	0.0	12
7	3.1	0.7	0.0	11½
8	2.6	0.2	0.0	11
9	8.1	5.4	0.0	10½
10	12.1	12.1	0.6	10
11	4.9	1.1	0.0	13½
12	11.2	9.2	2.9	14
13	12.5	12.3	5.0	13
14	12.4	10.6	1.3	13½
15	12.9	12.6	2.4	14½
16	12.9	12.4	5.4	13½
17	10.4	9.6	0.6	13½
18	11.6	10.8	1.1	14
19	12.0	12.0	2.1	14
20	12.6	11.6	1.5	15
21	13.1	10.6	4.3	16
22	13.0	13.1	10.1	18
23	13.3	12.7	11.1	18

*For station location, see Figure 29.

Conclusions Based on the 1966-67 Survey

The temperature--dissolved oxygen--waste loading interrelationships and effects of ice cover are revealed.

Figure 29

February 9-10, 1967

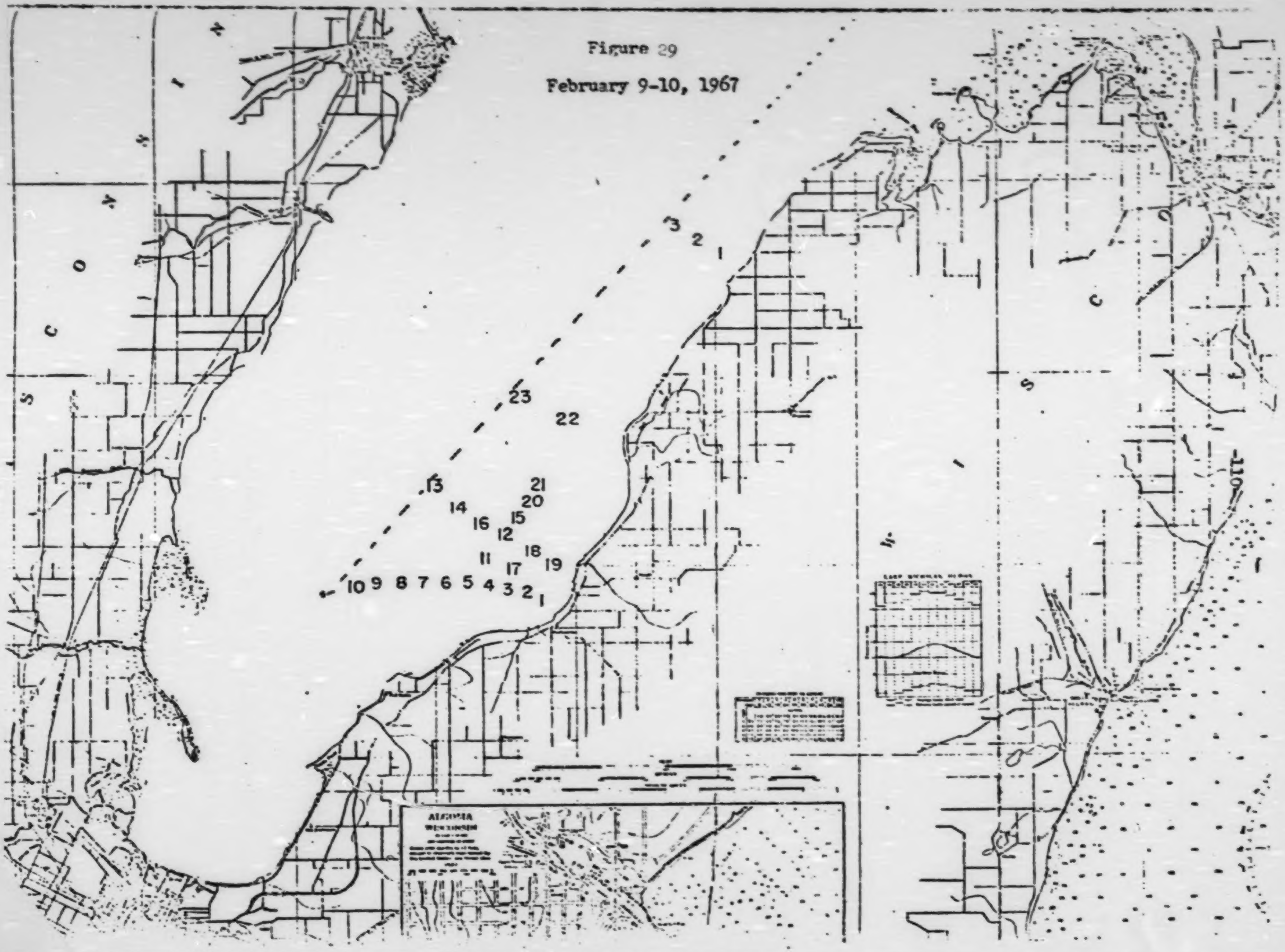

TABLE 23
D.O. CONCENTRATION FOR MIDDLE GREEN BAY
March 9 & 10, 1967

Field Station	Map Station*	Surface	Mid Depth	Bottom
March 9, 1967				
1	1	10.6	8.9	1.8
2	2	8.3	8.5	3.3
3	3	10.3	9.8	2.5
4	4	10.5	9.7	8.2
5	5	12.9	7.5	9.8
6	6	13.6	12.5	10.0
7	7	11.7	11.3	6.7
8	8	11.7	11.2	5.4
9	9	11.9	10.8	2.0
10	10	8.1	5.1	0.5
11	11	8.6	--	5.4
12	12	8.0	7.7	0.8
13	13	8.7	3.8	0.7
14	14	7.7	8.2	2.2
15	15	8.5	8.5	2.1
16	16	10.0	10.9	2.5
March 10, 1967				
1	17	7.8	--	9.0
2	18	9.1	8.0	2.2
3	19	10.4	10.0	0.9
4	20	--	6.4	--
5	21	11.3	11.2	1.8
6	22	11.2	11.2	4.5
7	23	11.1	10.4	9.0
8	24	11.5	10.5	6.0
9	25	11.4	11.5	6.9
10	26	11.6	11.6	3.4
11	27	11.6	11.3	0.9
12	28	11.0	10.4	0.1
13	29	10.[illegible]	9.9	4.9
x	x	0.1	--	0.1
y	y	--	--	9.9

*For Station Location see Figure 30

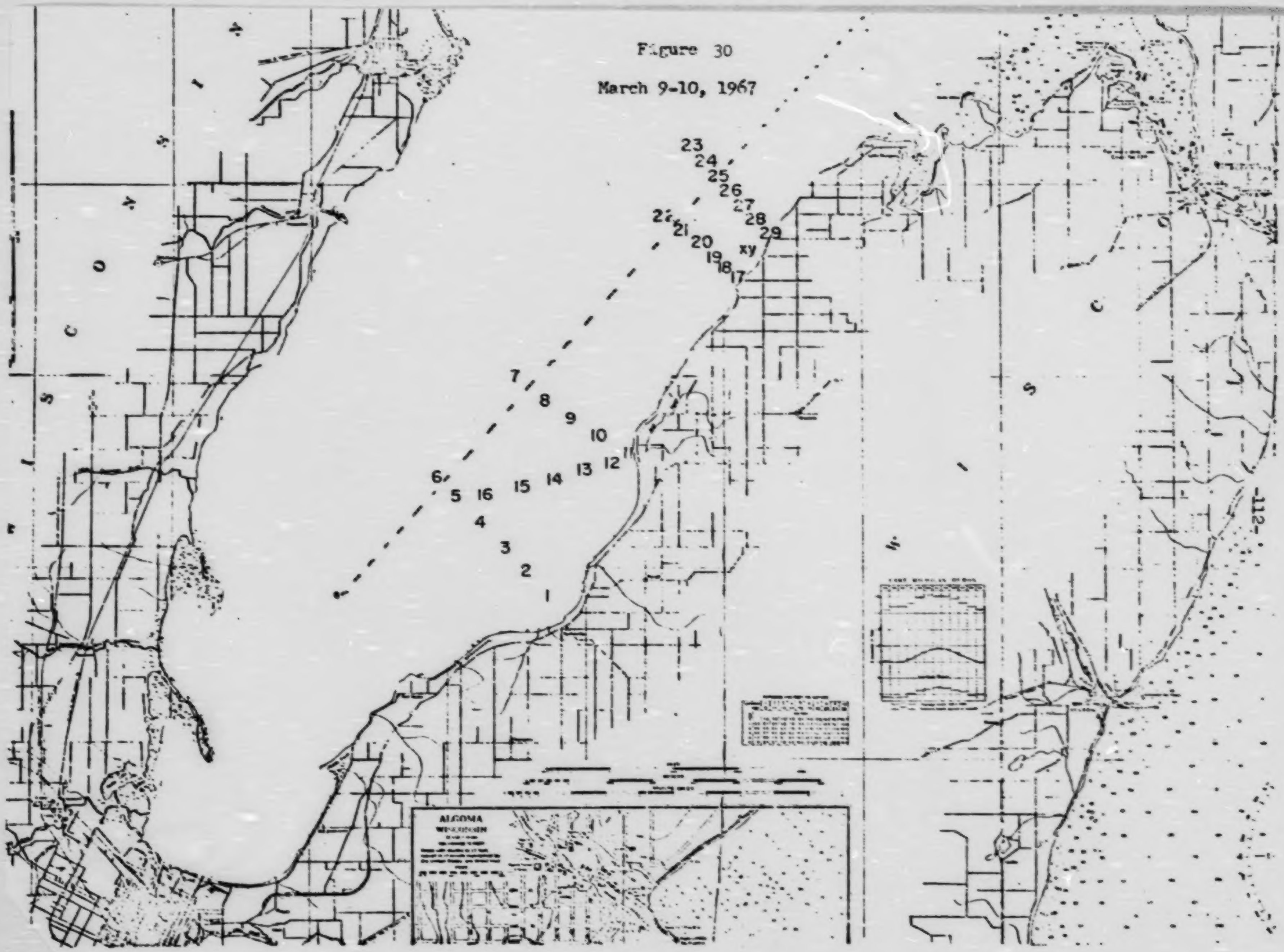

Figure 30

March 9-10, 1967

1. During warm weather, critical dissolved oxygen conditions are common on the Fox River from Appleton through the City of Green Bay and for a distance of 3-5 km into the Bay.

2. In the colder months, from about mid-November into April, the dissolved oxygen in the river is generally in excess of 5 mg/l. However, during the winter and particularly after prolonged heavy ice cover, low dissolved oxygen concentrations can extend into Green Bay for a distance of nearly 50 km.

3. During the period of open water, reaeration causes a recovery of oxygen levels beyond the Long Tail Point area.

In general, the dissolved oxygen levels in 1966-67 were lower in several regions of the Bay compared to levels for the same region in 1939.

Sager (1971) measured the dissolved oxygen concentrations in lower Green Bay on a weekly basis during the summer of 1970. Nine sampling stations were set up along a line which ran from the Fox River mouth to a point 22 km up the Bay (Figure 2).

It was estimated that about 60 percent of the estimated 500,000 pounds of 5-day, 20° C BOD discharged daily to Green Bay came from the Fox River (U.S. Federal Water Pollution Control Administration, 1966). The high BOD concentrations in the river lead to depressed oxygen levels for a distance of several miles into the Bay (Table 24).

On August 21, the dissolved oxygen level had dropped to 0.2 mg/l at the mouth of the river. In general, low values of dissolved oxygen were found near the river mouth, followed by rapid recovery of oxygen levels at distances removed from the river mouth.

TABLE 24. DISSOLVED OXYGEN CONCENTRATIONS--1970

STATIONS	I	II	III	IV	V	VI	VII	VIII	IX
June 17	3.65	4.73	7.75	7.70	7.75	7.79	7.79		
June 24									
July 1	5.76	4.70	5.05	9.80	9.44	9.70	9.70	9.70	9.70
July 10	6.46	6.71	7.27	8.67	9.54	9.49	8.79	8.79	8.99
July 22		5.50	6.59	5.96	8.59	8.13	8.20	7.73	7.60
August 5	4.00	3.35	8.78	8.49	8.60	8.31	7.92	7.68	7.60
August 12	2.72	5.54	10.45	9.51	9.64	9.24	9.23	9.14	9.89
August 21	0.20	5.37	8.27	10.61	9.58	8.73	8.95	8.94	9.14

*See Figure 2 for station locations.

Summary

In summer, high biochemical oxygen demand and rapid assimilation of wastes at warm temperatures leads to a condition of zero or, at best, low dissolved oxygen concentration in the water of the Fox River as it enters Green Bay. The rapid assimilation of these waste continues in the lower Bay keeps oxygen concentrations low despite open waters and natural reaeration. Beyond Long Tail Point, the natural reaeration allows for a rapid recovery of dissolved oxygen concentrations. Recovery is aided in summer by photosynthesis associated with dense algal growth.

In winter, the concentrations of dissolved oxygen in the river remains high (8-10 mg/l) because of reduced assimilation processes at lower temperatures. Ice and snow cover on the Bay block the physical transfer of oxygen to the Bay. The result is that the slow assimilation of wastes continues for distances up to 50 km from the mouth of the Fox River. The flow pattern of river water causes these conditions to exist along the east side of the Bay.

PUBLIC ATTITUDES TOWARD GREEN BAY

The majority of people who use or have contact with Green Bay do so in a recreational sense. These people are usually not aware of the many aspects of water quality which are important in Green Bay. Ditton and Goodale (1972) have surveyed the attitudes of those who use Green Bay in an attempt to more precisely define those aspects of water quality which are important to these people. These attitudes should play a significant role in planning the allocation of Green Bay resources.

The recreational use of water has been the most rapidly growing use of water. Recreational requirements of the Great Lakes Basin population may triple from 637 million recreational days in 1970 to 1.9 billion recreational days in 2020 (Great Lakes Basin Commission, 1971).

The commission found that 44 percent of the population preferred water-based activities over any other. While population levels and recreation demands in the Great Lakes Basin are both increasing, the effective supply of Lake Michigan water is being systematically reduced through conflicting water uses. These conflicts have resulted in degraded water quality conditions, closed beaches and reduced shoreland property values.

The multiple use concept of management has recreation as but one water use. Other uses include navigation, waste disposal, power generation, flood control, wildlife conservation, industrial water supply and irrigation. Theoretically, Lake Michigan is supposed to support all these uses. The term multiple use has come to stand for conflicting water uses eventually leading to impairment or displacement of some uses.

The passage of the Federal Water Project Recreation Act (PL 89-72) granted statutory authority for outdoor recreation as an equal among project purposes. The act recognized that the federal government had a responsibility to meet at least part of the demand for outdoor recreation. In addition to impaired water quality, inappropriate shoreland development, grandfather clauses in zoning ordinances, erosion processes, and lack of public access and/or facilities are shoreland conditions that restrict the optimal recreational use of the Lake Michigan coastal zone.

A decline in water quality in Green Bay has had several effects on marine recreational uses of the Bay and the attitude of people toward the Bay. A large dislocation of recreational use of Green Bay has occurred, particularly in the southern regions and particularly for body contact and partial body contact recreation. This is not a recent phenomenon, but one of gradual erosion over a period in excess of the four decades for which some documentation is available. The economic loss is substantial. Individual loss occurs in time and money for dislocation. There is a community loss of revenue due to suppressed value of adjacent properties. There is a loss of revenue which accrues from diminished recreational uses. There is a loss of weekend and seasonal trade. There is a loss of aesthetics. Smell and dead fish reduce the recreational potential of Green Bay waters for noncontact users.

Different groups are deterred by different conditions as they view them--either the perception or the condition must be changed, depending on how closely perception matches actual conditions.

The survey by Ditton and Goodale (1972) can be used by economists, planners, state and local officials, educators and numerous other interested parties as a guide to the demand for recreational resources in Green Bay by user group and location and by place of residence and other categories. Water quality and characteristics as perceived by users rather than as monitored by scientists can be used to determine the ramifications of action designed to improve the condition of the Bay.

REVIEW OF HISTORICAL DATA SOURCES
AND GENERAL COMMENTS

Pollution control enforcement became a reality in Wisconsin when the 1927 state legislature created the Committee on Water Pollution, granted authority for the issuance of orders and provided penalties for the violation of orders. The committee was charged with the responsibility of coordinating all state activities concerning water pollution control and one of its first activities, in conjunction with representatives of the pulp and paper industry and the state Board of Health, was to engage in a series of surveys of all pulp and paper mills throughout the state.

These Cooperative Annual Wastewater Surveys provided the means for monitoring the progress of the industry's efforts to improve the quality of its waste discharges in accordance with an agreement reached by pulp and paper mill executives and the participating state agencies in 1926. These early improvements included the reduction of fiber losses by way of savealls and recirculation systems and more efficient use of manufacturing chemicals. Appendix I presents the results of these surveys for mills located along the Lower Fox, Oconto, Peshtigo and Menominee Rivers, for the period of 1950 - 1967 when the mill surveys were discontinued. Data for 1971 and 1973 were obtained from the Wisconsin Pollutant Discharge Elimination System (WPDES) permit files and the Wisconsin Department of Natural Resources' NR 101 monthly industrial reporting files respectively. The limitations for 1975 and 1977 correspond to proposed EPA effluent guidances as established in accordance with the Federal Water Pollution Control Act Amendments of 1972. These guideline figures are subject to revision and represent 30-day maximum allowable averages. Appendix II briefly describes existing and proposed wastewater treatment facilities at the various pulp and paper mills of interest to this study.

At the time of the inception of the Committee on Water Pollution, the lack of adequate treatment of municipal wastes was of great concern, primarily because of the public health hazards involved. As a result, the state was divided into 28 major drainage basins for the purpose of informing local communities about the necessity for treatment of sewage and industrial wastes. By 1940, approximately 90 percent of the sewered population of the state was connected to treatment plants and by 1971, 76 percent of the existing plants provided secondary biological treatment. Drainage basin surveys have been conducted throughout the state at various intervals and have been instrumental in defining all significant point sources of pollution and evaluating river conditions in relation to those sources. Appendix V summarizes the results of the most recent basin survey for the Lower Fox, Oconto, Peshtigo, and Menominee Rivers and identifies the location of each point source in terms of River miles from the mouth of the respective rivers. The basin survey reports are now the responsibility of the Water Quality Evaluation Section, Bureau of Water Quality, Wisconsin Department of Natural Resources (WDNR).

River waste loadings from municipal sewage treatment plants are listed in Appendix III. The tables present both treated and known raw sewage loadings whereas the graphs depict only the treated effluent data. Raw sewage bypass, as listed in the appendix, refers to bypass at the treatment plant as a result of overloaded conditions. This does not include bypassing through overflows in combined sewer systems, designed for the collection of both municipal sewage and storm water runoff. For those years in which bypass data are not listed, bypassing probably occurred but was not monitored.

In addition to the proposed changes and improvements at various sewage treatment plants, as described in appendix IV, and in accordance with the agreements reached by the participating members of the Lake Michigan Enforcement Conference held in 1968, it is the goal of the state of Wisconsin to control pollution from all combined sewerage systems by July, 1977. This action includes the separation of all existing combined sewers and the prohibition of this type of collection in new developments except where alternate techniques can be employed. Until recently, most of the fourteen communities of interest to this study had utilized combined sewers. As of this writing, only De Pere, Oconto and Marinette have yet to complete their separation programs.

The enforcement conference also provided a recommendation for phosphorus removal from all municipal wastewater discharges. Section NR 102.04 of the Wisconsin Administrative Code, dated September, 1973, incorporates this recommendation by stating:

> Communities with a population of 2,500 and over in the lakes Michigan and Superior basins shall achieve an 85% reduction of phosphorus on an annual basis, and there shall be a commensurate removal from industrial wastes containing more than 2 mg/l of total phosphorus and having an annual phosphorus discharge greater than 8,750 pounds.

A proposal is now being considered which would replace "85% reduction" with a limit of 1 mg/l of total phosphorus on a monthly average basis.

Information for the Green Bay Metro treatment plant for the years 1946 - 1962 was obtained from the Annual Report of the Green Bay Metropolitan Sewerage District Commission while the data for 1966, and for the years prior to 1971 for all remaining treatment plants, are found in their respective basin survey reports. BOD_5 and suspended solids data for 1971 - 1973 were obtained from the monthly Sewage Treatment Plant Operator Reports whereas projected waste loadings correspond to proposed EPA guidances and represent maximum allowable 30-day averages.

Sewage treatment plant nutrient data was acquired from several sources including: 1) 1968 data - basin survey reports of 1969 for the Oconto, Peshtigo and Menominee Rivers; 2) 1971 data - report of Sager and Wiersma, 1972; 3) 1972 data - Summary Report on Water Quality and Wastewater Discharges during the summer of 1972, by the Water Quality Evaluation Section, Bureau of Water Quality, WDNR; and 4) 1973 data - Treatment Plant Operator Reports, 24-hour composite surveys, and individual grab samples. Kjeldahl nitrogen (KJEL-N) refers to the particulate and dissolved organic fractions of nitrogen plus inorganic ammonia nitrogen (NH_3-N). Total -P includes soluble and particulate organic and inorganic phosphorus fractions whereas soluble phosphorus (SOL-P) refers only to the dissolved orthophosphate (PO_4) species as derived by filtration of water samples through 0.45 micron filter paper prior to analysis.

Appendix VI is a summary of surface water quality surveys. The data for 1950 - 1960 are the results of cooperative stream surveys which were carried out in conjunction with the mill surveys. Data for the remaining years, 1961 - 1973, were obtained from four of the 43 monthly monitoring stations located throughout the state, the results of which are compiled by the Surveillance Section, Bureau of Water Quality, WDNR. All river flow data were collected by the U.S. Geological Survey.

The interpretation of the combined effects of municipal and industrial wastes on Green Bay requires at least a reasonable account of actual waste loadings entering the bay from its tributaries. Appendix XI is a summation of 5-day BOD loadings from the Lower Fox, Oconto, Peshtigo and Menominee Rivers for the years 1956 - 1973. The loadings were calculated from the data in Appendix VI according to the following formula:

$$\underset{(\text{mg/l})}{\overset{\text{BOD}_5}{\text{Concentration}}} \ \text{X} \ \underset{(\text{CFS})}{\text{Flow}} \ \text{X} \ 5.4 = \underset{(\text{Pounds/day})}{\text{Loading}}$$

In all cases the river sampling stations, from which the *actual loadings* were determined, are upstream from one or more important point source. In order to arrive at the *estimate* of total loading from each river, the combined downstream point source loadings, for those years in which complete data are available, were added to the actual loadings. This is valid because of the proximity of the point sources to the river sampling stations. The Peshtigo estimate will be somewhat inflated since the last major point source is about 10 miles upstream from the bay. Data for the years 1956 - 1960 are averages for the summer months only and will reflect a seasonal influence, especially in regards to the levels of dissolved oxygen.

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APPENDIX I.

LOWER FOX, OCONTO, PESHTIGO AND MENOMINEE RIVERS - PULP AND PAPER MILL PRODUCTION AND RIVER LOADINGS, 1950-1977

GREEN BAY PACKAGING INC. - GREEN BAY

Year	Production (tons/day) Semi-Chemical Pulp	Paper	Discharge MGD	BOD$_5$ Lb/day	BOD$_5$ Kg/day	Suspended Solids Lb/day	Suspended Solids Kg/day
1952	90	---	2.497	18,080	8,199	3,580	1,624
1953	136	---	3.120	16,380	7,429	4,120	1,869
1954	149	---	1.485	14,460	6,558	2,560	1,161
1955	172	---	3.101	16,280	7,383	9,480	4,299
1956	193	---	3.941	31,820	14,431	4,720	2,141
1957	182	---	3.260	30,780	13,959	6,660	3,020
1958	154	---	2.900	36,280	16,454	9,940	4,508
1959	186	---	2.500	37,760	17,125	8,000	3,628
1960	182	---	3.170	38,900	17,641	7,100	3,220
1961	187	---	3.100	39,580	17,950	6,320	2,866
1962	189	---	2.780	34,400	15,601	6,740	3,057
1963	200	233	3.380	45,960	20,844	9,860	4,472
1964	196	242	3.150	48,100	21,814	5,260	2,385
1965	191	246	2.100	33,300	15,102	5,340	2,422
1966	184	242	2.827	25,720	11,664	5,940	2,694
1967	169	240	3.440	21,440	9,723	5,400	2,449
1971	---	285	2.600	19,865	9,009	2,475	1,122
1973	---	316	1.786	1,355	614	465	211
1975 (Sept. 30)		---	-----	1,600	726	1,200	544
1977 (July 1)		---	-----	1,600	726	1,200	544

CHARMIN PAPER CO. - GREEN BAY

Year	Production (Tons/Day) Groundwood Pulp	Sulfite Pulp & Paper	Discharge MGD	BOD$_5$ Lb/Day	BOD$_5$ Kg/Day	Suspended Solids Lb/Day	Suspended Solids Kg/Day
1950	-	298	6.368	52,710	23,909	7,000	3,175
1951	-	405	6.393	-	-	5,900	2,676
1952	-	452	5.341	32,060	14,540	5,700	2,585
1953	-	433	8.567	47,370	21,488	13,060	5,923
1954	-	434	6.542	66,630	30,222	8,440	3,828
1955	-	482	6.396	38,300	17,370	8,200	3,719
1956	38	521	9.381	34,300	15,556	15,260	6,921
1957	34	548	12.498	30,660	13,905	15,820	7,175
1958	34	585	12.563	41,956	19,028	17,314	7,852
1959	35	522	13.242	42,560	19,302	13,620	6,177
1960	16	563	13.037	47,220	21,415	15,380	6,975
1961	10	573	12.661	60,030	27,229	11,776	5,341
1962	12	660	11.081	68,990	31,289	24,288	11,015
1963	17	832	14.557	48,770	22,118	23,208	10,525
1964	14	862	15.482	56,932	25,820	25,220	11,438
1965	12	934	14.561	46,148	20,929	18,078	8,199
1966	7	1,111	15.409	45,636	20,692	28,266	12,819
1967	-	1,199	13.932	35,527	16,112	26,331	11,941
1971	-	-	13.657	49,200	22,313	12,950	5,873
1973	-	1,526	14.522	43,802	19,865	12,674	5,748
1975 (Sept. 30)		-	-	7,630	3,460	8,500	3,855
1977 (July 1)		-	-	7,630	3,460	8,500	3,855

AMERICAN CAN CO. - GREEN BAY

Year	Production (Tons/Day) Sulfite Pulp	Groundwood Pulp	Paper	Discharge MGD	BOD$_5$ Lb/Day	Kg/Day	Suspended Solids Lb/Day	Kg/Day
1950	126	-	172	9.315	36,860	16,716	6,945	3,150
1951	132	-	172	7.214	47,520	21,551	5,780	2,621
1952	134	-	205	8.531	57,180	25,932	8,300	3,764
1953	128	73	194	8.703	39,800	18,050	9,480	4,299
1954	128	79	254	9.954	41,460	18,803	10,720	4,862
1955	128	84	340	10.023	47,120	21,370	8,880	4,027
1956	130	102	370	9.229	31,160	14,132	10,640	4,825
1957	133	103	386	10.435	44,520	20,190	14,520	6,585
1958	134	86	314	13.247	43,480	19,719	22,740	10,313
1959	130	105	337	15.496	47,440	21,515	23,880	10,830
1960	129	100	352	15.137	51,760	23,474	8,840	4,009
1961	140	102	361	17.097	41,000	18,594	7,720	3,501
1962	139	89	377	19.891	69,780	31,646	12,140	5,506
1963	136	96	415	19.125	63,280	28,698	10,600	4,807
1964	137	79	415	19.627	44,800	20,317	9,600	4,354
1965	-	-	-	-	-	-	-	-
1966	137	60	437	16.300	43,160	19,577	14,460	6,559
1967	140	68	462	18.600	57,440	26,050	14,228	6,453
1971	159	52	386	17.900	87,995	39,907	29,894	13,557
1973	154	68	463	11.214	32,241	14,622	7,257	3,291
1975 (Sept. 30)		-	-	-	7,650	3,469	5,200	2,358
1977 (July 1)		-	-	-	7,650	3,469	5,200	2,358

FORT HOWARD PAPER CO. - GREEN BAY

Year	Production (Tons/Day) Groundwood Pulp	Deinked Pulp	Paper	Discharge MGD	BOD$_5$ Lb/Day	Kg/Day	Suspended Solids Lb/Day	Kg/Day
1950	9	---	228	7.236	13,180	5,977	11,380	5,160
1951	16	---	311	8.307	14,420	6,540	15,800	7,166
1952	16	---	330	8.621	23,140	10,494	12,780	5,796
1953	15	---	318	8.207	16,040	7,274	13,600	6,168
1954	15	---	329	13.634	21,700	9,841	15,100	6,848
1955	12	---	353	8.413	20,720	9,397	9,140	4,145
1956	10	---	385	8.275	23,040	10,449	12,040	5,460
1957	12	---	504	7.546	17,280	7,837	14,780	6,703
1958	12	---	506	8.068	16,000	7,256	16,200	7,347
1959	14	---	534	9.472	19,580	8,880	16,920	7,673
1960	13	---	596	10.363	22,620	10,258	16,220	7,356
1961	10	---	616	10.073	25,820	11,710	17,060	7,737
1962	10	278	358	10.345	30,940	14,032	23,760	10,776
1963	11	282	367	10.952	26,800	12,154	19,600	8,889
1964	10	310	345	11.746	26,180	11,873	26,920	12,208
1965	16	387	492	13.425	28,440	12,893	30,780	13,959
1966	4	395	486	11.405	32,720	14,839	27,880	12,644
1967	--	451	524	10.296	37,080	16,816	22,440	10,177
1971	--	---	---	15.200	49,774	22,573	37,334	16,932
1973	--	798	827	17.498	[illegible]	[illegible]	[illegible]	5,597
1975	--	---	---	---	10,200	4,626	20,000	9,070
1977	--	---	---	---	8,200	3,719	13,000	5,896

NICOLET PAPER CO. - DE PERE

Year	Production (tons/day) Paper	Discharge MGD	BOD_5 lb/day	BOD_5 Kg/day	Suspended Solids lb/day	Suspended Solids Kg/day
1950	26	0.917	60	27	1,320	599
1951	29	0.963	160	73	460	209
1952	29	1.135	40	18	460	209
1953	32	1.338	60	27	580	263
1954	30	1.333	76	34	334	151
1955	30	1.333	80	36	360	163
1956	31	1.334	60	27	560	254
1957	31	1.296	80	36	460	209
1958	32	1.255	40	18	180	82
1959	33	1.275	100	45	260	118
1960	33	2.397	240	109	1,400	635
1961	58	2.267	280	127	860	390
1962	32	2.681	980	444	2,800	1,270
1963	63	2.326	300	136	920	417
1964	87	1.747	200	91	460	209
1965	89	1.488	200	91	660	299
1966	95	1.623	580	263	1,960	889
1971	118	3.940	708	321	570	258
1973	162	3.299	586	266	977	443
1975 (Sept. 30)		-----	1,300	590	970	440
1977 (July 1)		-----	1,300	590	970	440

THILMANY PULP & PAPER DIV. - KAUKAUNA
HAMMERMILL PAPER CO.

Year	Production (tons/day) Kraft Pulp & Paper	Discharge MGD	BOD_5 lb/day	BOD_5 Kg/day	Suspended Solids lb/day	Suspended Solids Kg/day
1950	335	14.786	15,020	6,812	15,500	7,029
1951	378	13.986	25,260	11,456	20,760	9,415
1952	409	17.736	20,280	9,197	25,400	11,519
1953	467	16.661	14,160	6,422	53,800	24,399
1954	526	17.800	24,330	11,057	33,820	15,338
1955	520	15.200	14,440	6,549	21,580	9,787
1956	488	17.300	19,380	8,789	19,540	8,862
1957	487	18.800	25,200	11,429	25,560	11,592
1958	562	17.654	30,540	13,850	11,660	5,288
1959	613	21.270	71,460	32,408	13,180	5,977
1960	636	19.270	24,660	11,184	8,100	3,673
1961	629	22.140	34,760	15,764	5,540	2,512
1962	537	15.792	42,960	19,483	11,680	5,297
1963	664	21.266	23,260	10,549	16,520	7,492
1964	700	19.400	26,200	11,882	10,280	4,662
1965	672	23.626	33,080	15,002	19,380	8,789
1966	794	23.260	33,260	15,084	23,960	10,866
1967	835	23.790	16,180	7,338	9,760	4,426
1971	905	28.700	21,045	9,544	17,786	8,066
1973	1,004	22.749	16,213	7,353	17,684	8,020
1975 (Sept. 30)	-----	------	15,140	6,866	9,803	4,446
1977 (July 1)	-----	------	5,900	2,676	5,900	2,676

APPLETON PAPERS - COMBINED LOCKS MILL

Year	Production (tons/day) Groundwood Pulp	Deinked Pulp	Pulped Waste Paper	Paper	Discharge MGD	BOD_5 lb/day	BOD_5 kg/day	Suspended Solids lb/day	Suspended Solids kg/day
1950	40	33	--	205	2.814	2,540	1,152	9,720	4,408
1951	42	38	--	189	2.247	2,160	980	22,660	10,277
1952	37	43	--	202	2.797	3,180	1,442	25,920	11,755
1953	41	50	--	222	2.453	2,264	1,027	12,160	5,515
1954	41	50	--	196	2.713	2,280	1,034	9,300	4,218
1955	36	41	--	194	3.124	2,286	1,037	14,714	6,673
1956	38	53	--	203	3.579	5,520	2,503	13,280	6,023
1957	38	52	--	214	3.668	5,238	2,376	13,578	6,158
1958	21	68	--	199	3.745	5,980	2,712	14,980	6,794
1959	41	64	--	225	4.180	7,360	3,338	20,380	9,243
1960	23	54	--	201	4.556	10,560	4,789	23,320	10,576
1961	29	59	--	206	3.796	8,620	3,909	25,920	11,755
1962	39	52	--	218	3.272	8,540	3,873	23,600	10,703
1963	32	34	57	182	2.998	4,940	2,240	12,640	5,732
1964	56	45	63	225	3.150	9,880	4,481	16,520	7,492
1965	40	31	70	205	2.976	4,200	1,905	12,880	5,841
1966	18	62	61	224	3.048	5,760	2,612	11,060	5,016
1967	21	48	74	214	2.397	4,620	2,095	18,100	8,209
1971	--	--	--	---	5.930	19,600	8,889	43,381	19,674
1973	221	40	--	446	7.159	16,664	7,557	6,007	2,724
1975	(Sept. 30)	--	--	---	-----	15,607	7,078	6,758	3,065
1977	(July 1)	--	--	---	-----	3,650	1,655	4,130	1,873

KIMBERLY - CLARK, KIMBERLY MILLS

Year	Production (Tons/Day) Sulfite Pulp	Paper	Discharge MGD	BOD_5 Lb/Day	BOD_5 Kg/Day	Suspended Solids Lb/Day	Suspended Solids Kg/Day
1950	93	378	11.137	40,540	18,385	21,400	9,705
1951	125	354	11.137	59,460	26,966	22,820	10,349
1952	82	278	8.755	42,280	19,175	17,700	8,027
1953	101	368	9.965	44,920	20,372	29,800	13,515
1954	104	367	9.540	53,180	24,118	17,360	7,873
1955	95	368	8.357	35,200	15,964	20,020	9,079
1956	118	385	10.380	40,380	18,313	20,600	9,342
1957	94	471	12.546	30,580	13,868	48,040	21,787
1958	89	465	10.254	27,200	12,336	25,060	11,365
1959	89	459	10.350	42,880	19,447	34,640	15,710
1960	103	480	10.022	54,880	24,889	30,860	13,995
1961	77	455	11.476	56,200	25,488	34,820	15,791
1962	97	453	11.469	79,380	36,000	41,600	18,866
1963	71	470	12.491	44,620	20,236	46,230	20,966
1964	60	480	11.639	38,700	17,551	41,400	18,776
1965	84	395	12.593	52,740	23,918	39,440	17,887
1966	78	486	11.494	28,600	12,970	52,180	23,664
1967	79	505	13.027	24,560	11,138	57,560	26,104
1971	66	530	47.598	36,255	16,442	62,858	28,507
1973	132	606	37.211	8,196	3,717	14,244	6,460
1975	(Sept. 30)	---	---	8,077	3,663	12,246	5,554
1977	(July 1)	---	---	2,000	907	3,000	1,360

CONSOLIDATED PAPER CO. - APPLETON

Year	Production (tons/day) *Sulfite Pulp	Discharge MGD	BOD5 lb/day	BOD5 kg/day	Suspended Solids lb/day	Suspended Solids kg/day
1950	140	4.909	71,200	32,290	1,840	834
1951	133	4.729	80,780	36,635	2,140	970
1952	121	10.463	57,280	25,977	2,620	1,188
1953	121	10.915	37,420	16,970	4,560	2,068
1954	119	11.772	36,800	16,689	4,280	1,941
1955	153	11.342	36,340	16,481	3,940	1,787
1956	151	11.136	34,820	15,791	4,600	2,086
1957	133	10.816	45,710	20,730	5,264	2,387
1958	125	10.945	25,660	11,637	3,220	1,460
1959	125	11.943	31,460	14,268	6,720	3,048
1960	138	12.222	59,120	26,812	7,120	3,229
1961	136	12.204	51,300	23,265	9,420	4,272
1962	137	11.425	43,140	19,565	10,400	4,717
1963	178	12.503	35,160	15,946	13,360	6,059
1964	159	11.878	30,120	13,660	12,500	5,669
1965	162	7.965	33,620	15,247	15,240	6,912
1966	150	8.131	30,880	14,004	8,260	3,746
1967	160	7.639	25,626	11,622	3,900	1,769
1971	---	**68.246	52,406	23,767	27,185	12,328
1973	197	8.219	35,944	16,301	9,454	4,288
1975 (Sept. 30)		------	17,000	7,710	6,000	2,721
1977 (July 1)		------	2,500	1,134	1,500	680

* Bleached and unbleached 1950-1961, Bleached only 1962 - present
** 51 MGD from previously nonmonitored discharge outlet

RIVERSIDE PAPER CO. - APPLETON

Year	Production (tons/day) Pulp	Production (tons/day) Paper	Discharge MGD	BOD5 lb/day	BOD5 Kg/day	Suspended Solids lb/day	Suspended Solids Kg/day
1950	--	74	0.609	400	181	380	172
1951	47	85	0.698	400	181	980	444
1952	42	75	0.605	460	209	920	417
1953	38	75	0.702	538	244	2,908	1,319
1954	43	80	0.658	582	261	968	439
1955	33	82	0.722	222	101	1,600	726
1956	[illegible]	82	0.690	784	356	1,546	701
1957	[illegible]	83	0.685	526	238	1,376	624
1958	50	85	0.685	832	377	1,724	782
1959	50	80	2.030	3,548	1,609	2,942	1,334
1960	50	82	2.351	3,424	1,553	4,822	2,187
1961	50	82	2.351	3,840	1,742	6,380	2,893
1962	50	82	2.351	2,420	1,098	7,500	3,401
1963	17	80	2.101	3,020	1,370	9,180	4,163
1964	17	88	2.110	2,340	1,061	4,420	2,004
1965	35	82	1.892	1,940	880	5,200	2,358
1966	35	84	2.529	1,500	680	7,820	3,546
1967	30	88	2.262	1,340	608	7,840	3,556
1971	--	95	2.930	1,805	818	10,698	4,852
1973	--	113	0.840	390	177	747	339
1975 (Sept. 30)		---	-----	870	394	830	376
1977 (July 1)		---	-----	870	394	830	376

JOHN STRANGE DIV. MENASHA CORP. - MENASHA

Year	Production (tons/day) Paper	Discharge MGD	BOD$_5$		Suspended Solids	
			lb/day	Kg/day	lb/day	Kg/day
1950	171	2.035	1,560	707	3,420	1,551
1951	173	1.827	560	254	2,420	1,098
1952	169	2.783	2,600	1,179	5,400	2,449
1953	179	2.756	2,580	1,170	2,860	1,297
1954	172	1.522	1,960	889	2,960	1,342
1955	201	2.471	5,100	2,313	5,240	2,376
1956	188	1.920	3,200	1,451	2,380	1,079
1957	202	3.028	4,980	2,259	9,240	4,190
1958	192	1.722	3,104	1,408	5,224	2,369
1959	202	2.652	1,464	664	3,146	1,427
1960	198	3.010	2,322	1,053	5,200	2,358
1961	204	2.570	1,660	753	3,200	1,451
1962	181	1.909	1,400	635	2,740	1,243
1963	189	2.095	1,440	653	3,200	1,451
1964	185	1.735	1,680	762	2,860	1,297
1965	217	3.221	5,620	2,549	2,020	916
1966	228	1.596	1,840	834	3,140	1,424
1967	175	1.323	900	408	1,940	880
1973	300	1.506	1,010	458	1,168	530
1975	(Sept. 30)	-----	657	298	1,949	884
1977	(July 1)	-----	650	295	400	181

GILBERT PAPER CO. - MENASHA

Year	Production (tons/day) Rag Pulp	Production (tons/day) Paper	Discharge MGD	BOD$_5$		Suspended Solids	
				lb/day	Kg/day	lb/day	Kg/day
*1960	18	70	-----	-----	---	-----	-----
1961	15	68	1.126	1,920	871	2,540	1,152
1962	12	59	1.086	1,200	544	1,980	898
1963	17	58	0.886	1,220	553	1,520	689
1964	17	62	0.928	1,360	617	2,640	1,197
1965	15	67	1.110	1,040	472	2,400	1,088
1966	16	69	0.891	740	336	640	290
1967	17	55	0.672	700	317	387	176
1971	--	--	0.070	27	12	1,219	553
1973	--	81	0.021	16	7	369	167

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*Prior to 1974, most process wastes diverted to Neenah-Menasha Severage Commission Treatment Plant. During 1974, remaining wastes will be sent to the municipal treatment plant.

GEORGE A. WHITING CO. - MENASHA

Year	Production (tons/day) Paper	Discharge MGD	BOD$_5$ lb/day	BOD$_5$ Kg/day	Suspended Solids lb/day	Suspended Solids Kg/day
1950	15	0.044	20	9	60	27
1951	15	0.123	40	18	280	127
1952	14	0.071	20	9	40	18
1953	15	0.371	100	45	460	209
1954	15	0.248	80	36	560	254
1955	15	0.325	120	54	200	91
1956	16	0.126	20	9	80	36
1957	17	0.212	120	54	340	154
1958	18	0.143	120	54	600	272
1959	18	0.216	40	18	600	272
1960	17	0.135	60	27	420	190
1961	17	0.038	60	27	600	272
1962	18	0.151	60	27	200	91
1963	18	0.242	100	45	320	145
1964	15	0.127	78	35	420	190
1965	17	0.148	128	58	374	169
1966	19	0.317	380	172	1,492	677
1967	17	0.175	232	105	1,776	805
1971	18	0.520	307	139	721	327
1973	28	0.562	532	241	1,415	642
1975 (Sept. 30)		-----	168	76	196	89
1977 (July 1)		-----	168	76	196	89

KIMBERLY-CLARK, LAKEVIEW MILL - MENASHA

Year	Production (tons/day) Paper	Discharge MGD	BOD$_5$ lb/day	BOD$_5$ Kg/day	Suspended Solids lb/day	Suspended Solids Kg/day
1950	156	5.256	1,900	862	4,360	1,977
1951	145	6.100	1,960	889	6,280	2,848
1952	150	5.300	2,120	961	5,880	2,667
1953	167	5.690	5,340	2,422	5,800	2,630
1954	167	5.350	2,720	1,234	4,920	2,231
1955	177	6.089	2,500	1,134	4,380	1,986
1956	174	5.963	2,440	1,107	1,200	544
1957	176	6.320	2,980	1,351	5,940	2,694
1958	168	5.142	2,060	934	5,040	2,286
1959	157	4.929	2,520	1,143	6,660	3,020
1960	164	5.199	1,920	870	4,580	2,077
1961	168	5.636	2,420	1,098	7,720	3,501
1962	185	5.794	2,540	1,152	7,180	3,256
1963	163	5.824	1,160	526	8,140	3,692
1964	180	5.438	1,840	834	4,340	1,968
1965	189	5.711	2,400	1,088	6,220	2,821
1966	154	5.249	1,460	662	6,760	3,066
1967	224	4.900	1,520	689	9,560	4,336
1971	---	5.368	1,878	852	1,486	674
1973	226	4.574	1,313	595	618	280
1975	---	-----	1,800	816	1,100	499
1977	---	-----	1,800	816	1,100	499

KIMBERLY-CLARK, BADGER GLOBE MILL - NEENAH

Year	Production (tons/day) Paper	Discharge MGD	BOD_5 Lb/day	BOD_5 Kg/day	Suspended Solids Lb/day	Suspended Solids Kg/day
1950	82	1.411	460	209	1,900	862
1951	83	1.175	260	118	1,260	571
1952	89	1.470	120	54	480	218
1953	84	1.938	960	435	1,260	571
1954	77	2.431	1,180	535	4,720	2,140
1955	88	2.389	440	200	1,820	825
1956	96	2.527	240	109	1,340	608
1957	92	2.137	800	363	2,240	1,016
1958	94	2.205	300	136	840	381
1959	95	1.897	560	254	900	408
1960	95	1.310	380	172	920	417
1961	94	1.619	440	200	1,240	562
1962	92	2.222	740	336	1,240	562
1963	89	2.005	520	236	1,320	599
1964	66	1.688	580	263	1,260	571
1965	--	----	---	---	----	---
1966	65	0.528	140	63	360	163
1967	50	0.333	96	44	184	83
1971	—	0.730	407	184	409	185
1973(April)	73	Process wastes diverted to municipal treatment plant				

KIMBERLY-CLARK, NEENAH DIV.

Year	Production (tons/day) Rag Pulp	Production (tons/day) Paper	Discharge MGD	BOD5 Lb/day	BOD5 Kg/day	Suspended Solids Lb/day	Suspended Solids Kg/day
1950	15	36	0.620	420	190	780	354
1951	15	37	0.614	20	9	438	199
1952	15	38	0.582	112	51	530	240
1953	15	38	0.570	162	73	388	176
1954	14	39	0.570	82	37	380	172
1955	14	39	0.588	126	57	386	175
1956	14	40	0.500	144	65	388	176
1957	13	41	0.456	170	77	330	150
1958	9	40	0.456	108	49	444	201
1959	10	46	0.456	154	70	470	213
1960	5	40	0.456	56	25	404	183
1961	9	58	1.323	894	405	2,740	1,243
1962	8	39	1.033	1,298	589	1,778	806
1963	10	59	1.266	1,160	526	2,860	1,297
1964	8	60	0.912	672	305	1,640	744
1965	9	52	0.828	588	267	1,450	658
1966	9	63	0.530	294	133	916	415
1967	9	51	0.637	316	143	1,326	601
1971	—	--	1.672	1,240	562	2,012	912
1973	--	71	0.245	73	33	2,228	1,010
1975	Process wastes to Municipal Treatment Plant						

AMERICAN CAN CO. - MENASHA

Year	Production (Tons/Day) Paper	Discharge MGD	BOD$_5$ Lb/Day	BOD$_5$ Kg/Day	Suspended Solids Lb/Day	Suspended Solids Kg/Day
1950	32.3	0.490	147	67	205	93
1951	32.4	0.452	171	78	359	163
1952	34.9	0.458	162	74	390	177
1953	31.4	0.324	130	59	336	152
1954	32.6	0.726	241	109	1,164	528
1955	32.2	0.436	161	73	757	343
1956	33.2	0.448	193	88	554	251
1957	37.4	0.556	349	158	2,451	1,112
1958	33.2	0.605	164	74	576	261
1959	29.7	0.510	92	42	413	187
1960	29.4	0.603	113	51	448	203
1961	30.2	0.505	90	41	304	138
1962	24.8	0.536	122	55	461	209
1963	17.6	0.298	25	11	137	62
1964	18.5	0.523	72	33	336	152
1965	16.2	0.469	595	270	286	130
1966	14.6	0.359	70	32	330	150

Converted to printing operation

BERGSTROM PAPER CO. - NEENAH

Year	Production (tons/day) Deinked Pulp	Production (tons/day) Paper	Discharge MGD	BOD$_5$ lb/day	BOD$_5$ kg/day	Suspended Solids lb/day	Suspended Solids kg/day
1950	85	110	3.250	5,620	2,549	20,290	9,202
1951	104	111	2.904	8,540	3,873	30,410	13,791
1952	92	109	2.625	8,460	3,837	27,502	12,472
1953	78	93	2.676	7,120	3,229	31,440	14,258
1954	94	102	3.007	9,460	4,290	29,836	13,531
1955	94	114	2.828	10,120	4,590	18,460	8,372
1956	109	130	3.013	10,220	4,635	33,700	15,283
1957	122	135	2.542	12,900	5,850	15,420	6,993
1958	142	147	3.208	15,220	6,902	30,740	13,941
1959	137	151	2.467	12,240	5,551	16,240	7,365
1960	136	129	2.531	15,240	6,916	32,760	14,857
1961	148	154	3.101	13,520	6,132	36,080	16,363
1962	139	142	2.953	14,440	6,549	30,640	13,896
1963	154	144	2.949	15,460	7,011	25,740	11,673
1964	162	144	2.833	14,800	6,712	49,000	22,222
1965	163	206	2.705	20,180	9,152	34,600	15,692
1966	171	301	3.269	17,720	8,036	41,780	18,948
1967	155	279	4.872	22,752	10,318	22,606	10,252
1971	---	---	11.287	24,491	11,107	13,906	6,307
1973	140	280	4.527	20,217	9,169	15,473	7,017
1975	(Sept. 30)	---	------	19,308	8,756	17,707	8,030
1977	(July 1) All process wastes to municipal treatment plant						

SCOTT PAPER CO. - OCONTO FALLS

Year	Production (tons/day) Sulfite Pulp	Production (tons/day) Paper	Discharge MGD	BOD$_5$ lb/day	BOD$_5$ Kg/day	Suspended Solids lb/day	Suspended Solids Kg/day
1950	75	45	3.307	51,122	23,185	6,206	2,814
1951	64	37	5.150	39,540	17,932	8,880	4,027
1952	66	38	3.676	52,540	23,828	4,600	2,086
1953	62	58	3.774	33,700	15,283	4,040	1,832
1954	62	72	4.016	34,320	15,565	3,700	1,678
1955	72	72	4.676	38,760	17,578	4,840	2,195
1956	73	87	4.549	7,820	3,546	3,380	1,533
1957	73	112	5.259	8,080	3,664	6,280	2,848
1958	80	108	4.538	7,060	3,202	7,920	3,592
1959	85	102	4.079	6,060	2,748	4,192	1,901
1960	88	107	4.445	8,620	3,909	4,380	1,986
1961	98	97	10.614	24,780	11,238	11,620	5,270
1962	95	114	11.191	20,680	9,379	10,060	4,562
1963	98	119	7.592	32,900	14,921	6,800	3,084
1964	94	115	11.087	32,600	14,784	12,620	5,723
1965	106	101	11.294	37,980	17,224	7,520	3,410
1966	112	112	12.228	39,680	17,995	6,400	3,810
1967	108	109	10.715	29,438	13,350	5,200	2,358
1971	---	---	12.865	51,443	23,330	10,675	4,841
1973	*224		11.198	51,035	23,145	7,880	3,574

1975
1977 } Interim effluent standards have not yet been established.

* Total pulp and paper production

Year	KJEL.-N lb/day	KJEL.-N Kg/day	NH$_3$-N lb/day	NH$_3$-N Kg/day	NO$_3$-N lb/day	NO$_3$-N Kg/day	TOTAL-P lb/day	TOTAL-P Kg/day
1971	5,278	2,394	3,826	1,735	10	4	101	46

BADGER PAPER MILLS - PESHTIGO

Year	Production (tons/day) Pulp	Production (tons/day) Paper	Discharge MGD	BOD$_5$ lb/day	BOD$_5$ Kg/day	Suspended Solids lb/day	Suspended Solids Kg/day
1950	85	77	4.275	31,340	14,213	4,620	2,095
1951	88	80	4.420	13,620	6,177	4,560	2,068
1952	90	82	4.420	17,800	8,072	3,840	1,742
1953	86	84	3.490	12,940	5,868	5,020	2,277
1954	86	84	3.900	15,440	7,002	3,740	1,696
1955	87	84	3.760	12,280	5,569	3,360	1,524
1956	90	90	4.584	8,700	3,946	4,200	1,905
1957	92	89	4.584	27,134	12,306	4,412	2,001
1958	91	90	4.564	19,246	8,728	4,262	1,933
1959	83	90	4.564	25,680	11,646	4,380	1,986
1960	84	91	4.728	30,440	13,805	6,540	2,966
1961	82	92	4.728	18,920	8,580	5,780	2,621
1962	83	93	4.820	12,480	5,660	3,740	1,696
1963	86	95	5.330	15,520	7,038	3,540	1,605
1964	71	93	5.180	6,200	2,812	3,860	1,750
1965	99	120	5.506	22,920	10,395	4,400	1,995
1966	92	124	5.506	28,380	12,871	7,280	3,302
1967	88	119	5.506	16,132	7,316	6,978	3,165
1971	89	146	6.080	20,878	9,468	5,703	2,586
1973	218	146	4.547	40,052	18,164	6,546	2,969

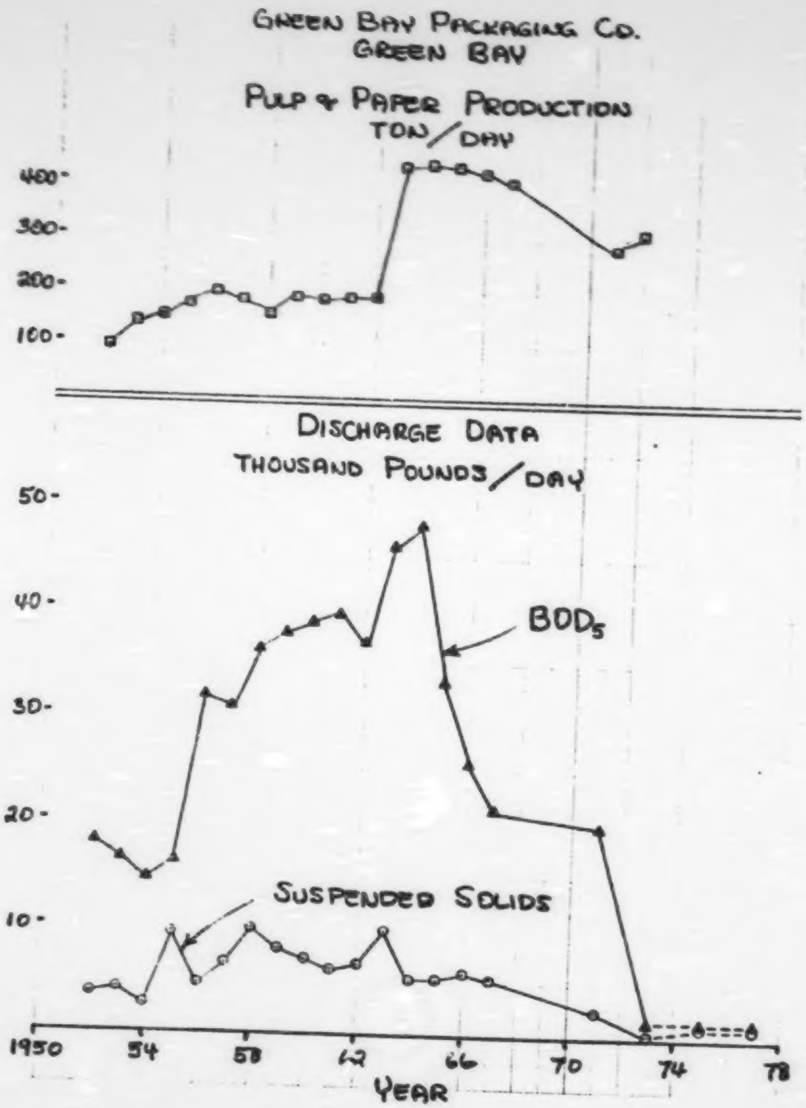
1975
1977 } Interim effluent standards have not yet been established.

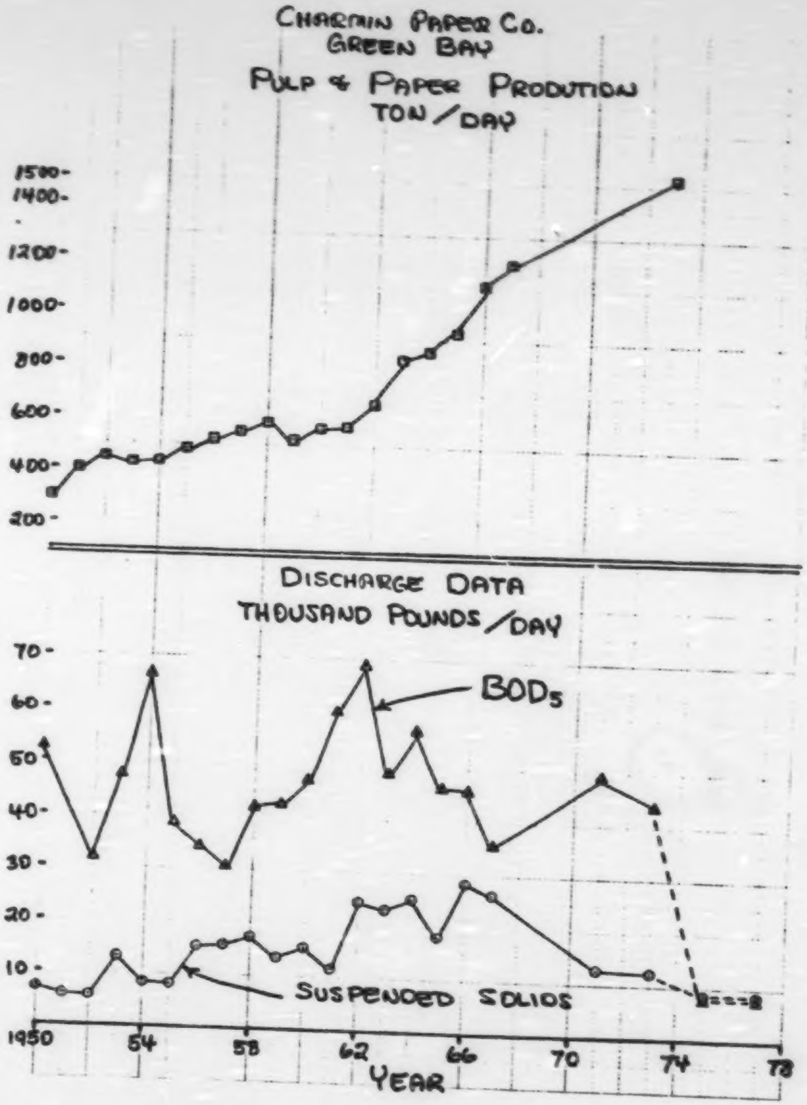
Year	KJEL.-N lb/day	KJEL.-N Kg/day	NH$_3$-N lb/day	NH$_3$-N Kg/day	NO$_3$-N lb/day	NO$_3$-N Kg/day	TOTAL-P lb/day	TOTAL-P Kg/day
1971	152	69	57	26	34	15	17	8

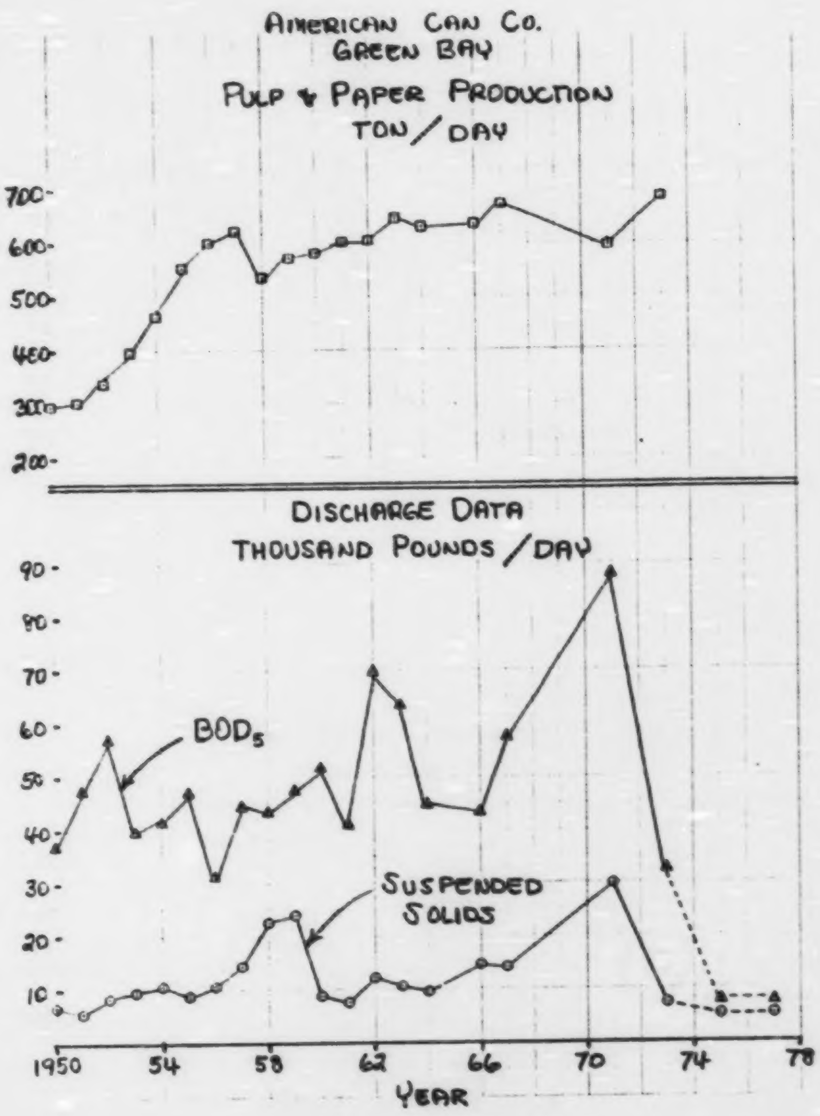
SCOTT PAPER CO. - MARINETTE

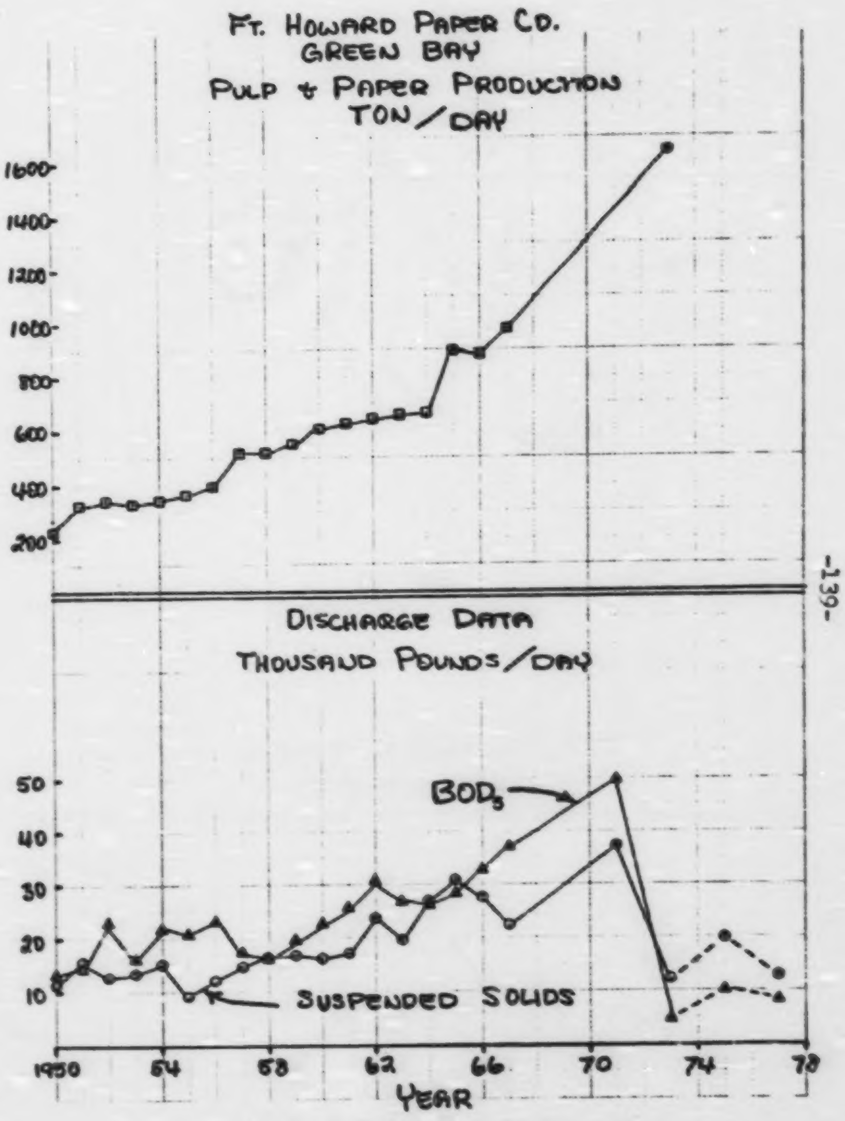
	Production (tons/day)			BOD_5		Suspended Solids	
Year	Sulfite Pulp	Paper	Discharge MGD	lb/day	Kg/day	lb/day	Kg/day
1950	32	80	2.679	15,900	7,211	3,860	1,750
1951	37	110	2.665	21,540	9,769	3,560	1,614
1952	46	120	4.382	20,280	9,197	5,060	2,295
1953	46	134	5.050	21,780	9,878	5,480	2,485
1954	46	142	5.149	30,800	13,968	7,280	3,302
1955	42	142	6.398	25,580	11,601	5,220	2,367
1956	42	131	6.925	26,060	11,818	7,400	3,356
1957	45	132	6.655	24,862	11,275	7,346	3,332
1958	44	149	7.171	30,650	13,900	10,256	4,652
1959	50	150	7.435	30,364	13,770	8,964	4,065
1960	50	157	6.653	37,942	17,207	7,338	3,328
1961	50	157	6.497	36,228	16,430	6,804	3,086
1962	51	160	7.615	33,604	15,240	7,624	3,458
1963	54	156	7.313	52,880	23,982	12,228	5,546
1964	50	159	7.640	49,014	22,229	9,904	4,492
1965	48	178	8.181	65,396	29,658	9,496	4,307
1966	50	194	6.843	34,580	15,682	9,120	4,136
1967	54	188	5.810	58,600	26,576	9,980	4,526
1971	--	187	7.840	56,128	25,455	12,634	5,730
1973	--	---	4.619	1,755	796	2,985	1,354
1975	(Dec. 31)	---	-----	2,000	910	2,000	910
1978	(Dec. 31)	---	-----	1,500	680	1,125	510

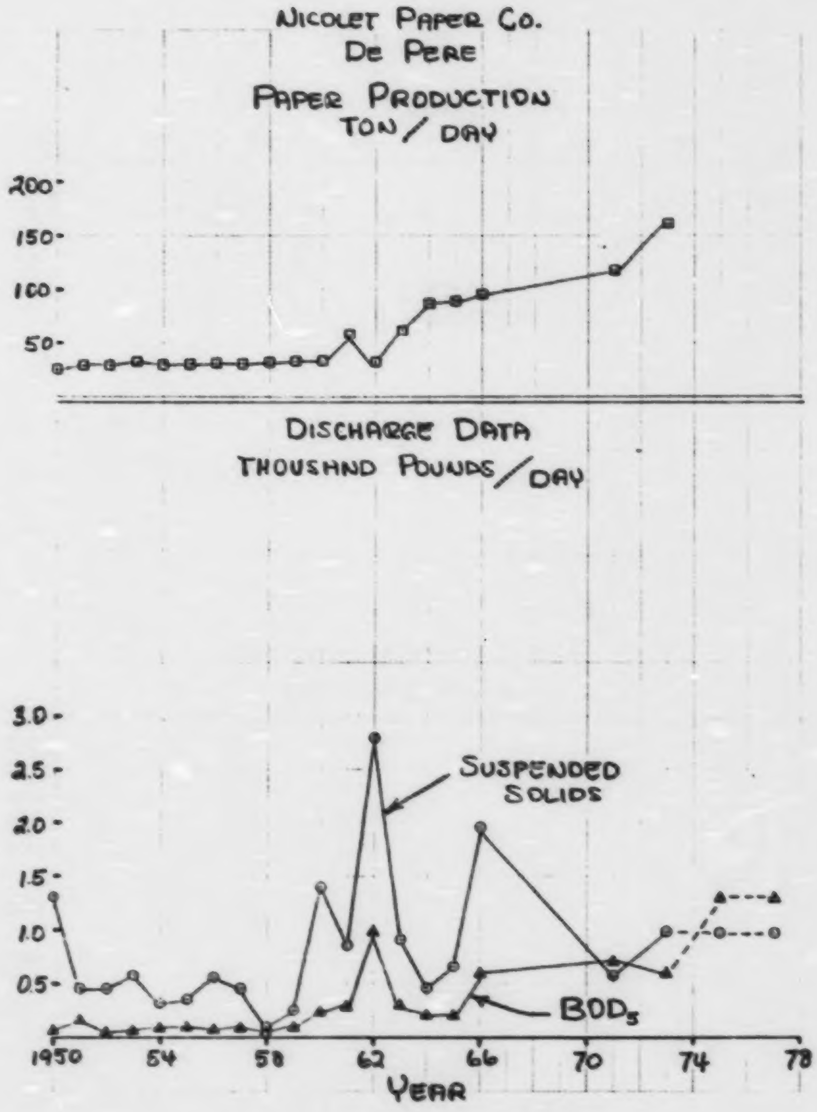
	KJEL.-N		NH_3-N		NO_3-N		TOTAL-P	
Year	lb/day	Kg/day	lb/day	Kg/day	lb/day	Kg/day	lb/day	Kg/day
1971	111	50	13	6	1.6	<1.0	35	16

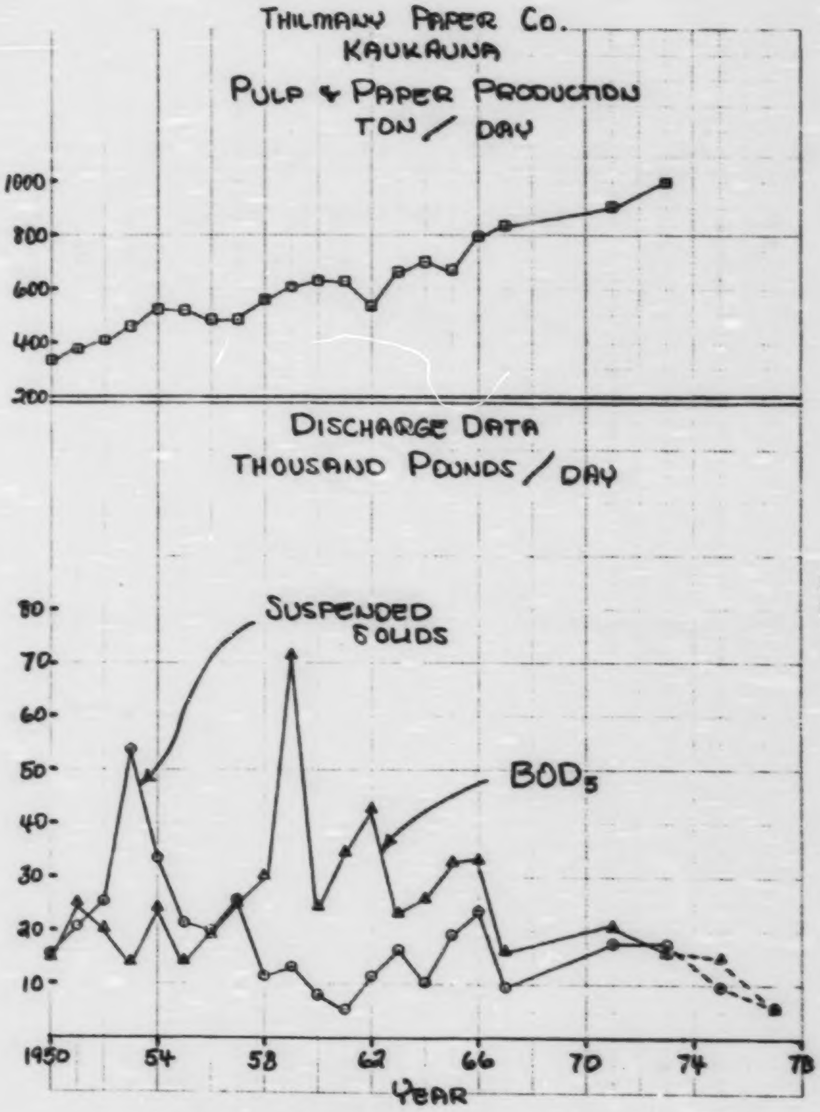

GREEN BAY PACKAGING CO.
GREEN BAY
PULP & PAPER PRODUCTION
TON/DAY
400-
300-
200-
100-
DISCHARGE DATA
THOUSAND POUNDS/DAY
50-
40-
30-
20-
10-
BOD5
SUSPENDED SOLIDS
1950
54
58
62
66
70
74
78
YEAR

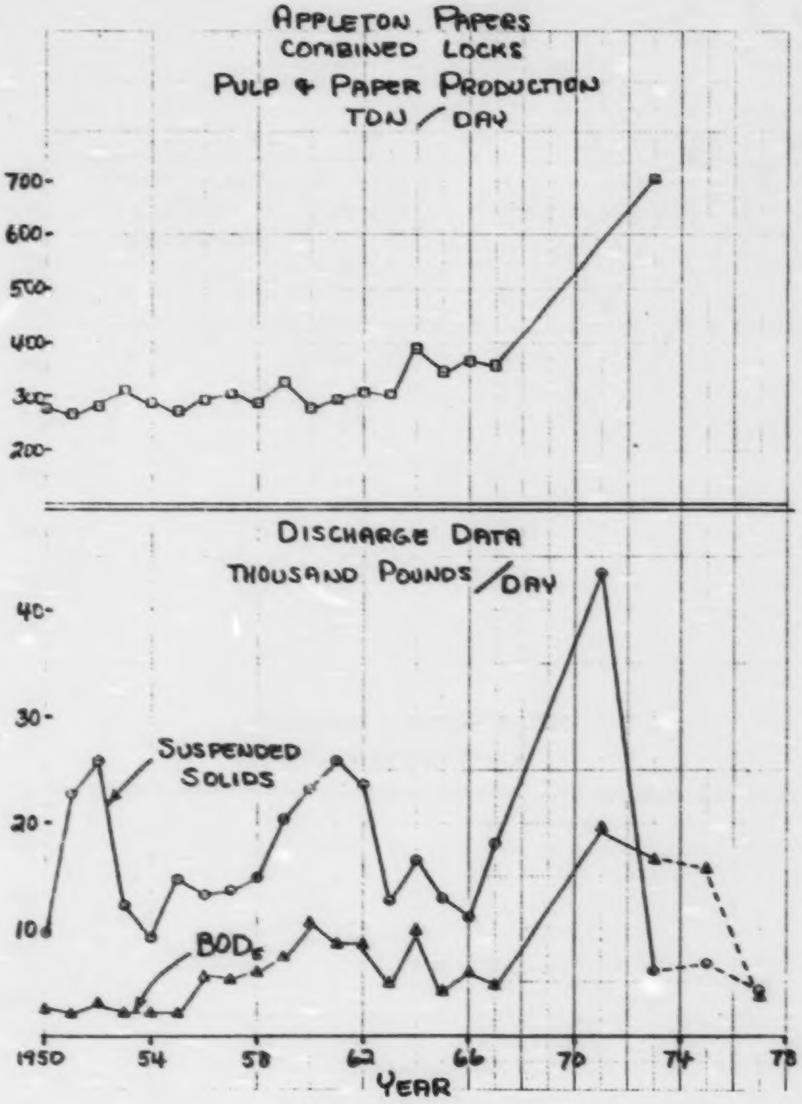

CHARMIN PAPER CO.
GREEN BAY
PULP & PAPER PRODUTION
TON/DAY
1500-
1400-
1200-
1000-
800-
600-
400-
200-
DISCHARGE DATA
THOUSAND POUNDS/DAY
70-
60-
50-
40-
30-
20-
10-
BOD5
SUSPENDED SOLIDS
1950
54
58
62
66
70
74
78
YEAR

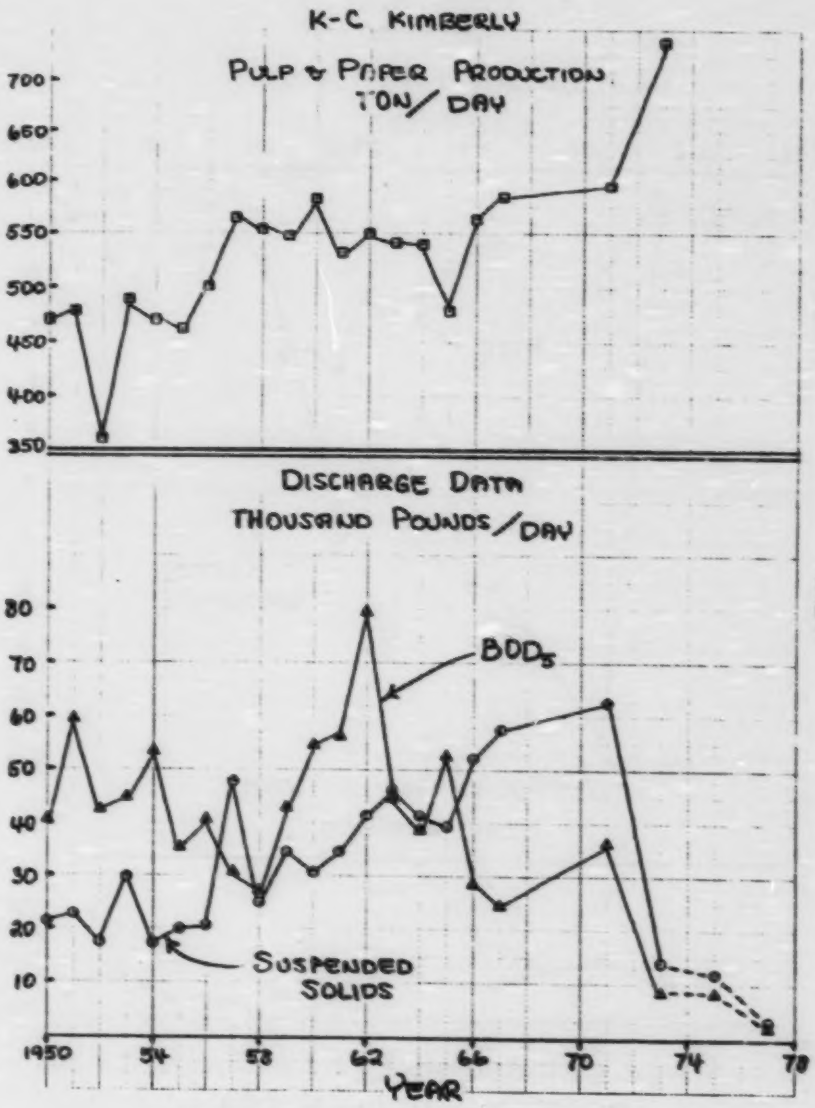

AMERICAN CAN CO.
GREEN BAY
PULP & PAPER PRODUCTION
TON / DAY
700
600
500
400
300
200
DISCHARGE DATA
THOUSAND POUNDS / DAY
90
80
70
60
50
40
30
20
10
BOD5
SUSPENDED SOLIDS
1950
54
58
62
66
70
74
78
YEAR

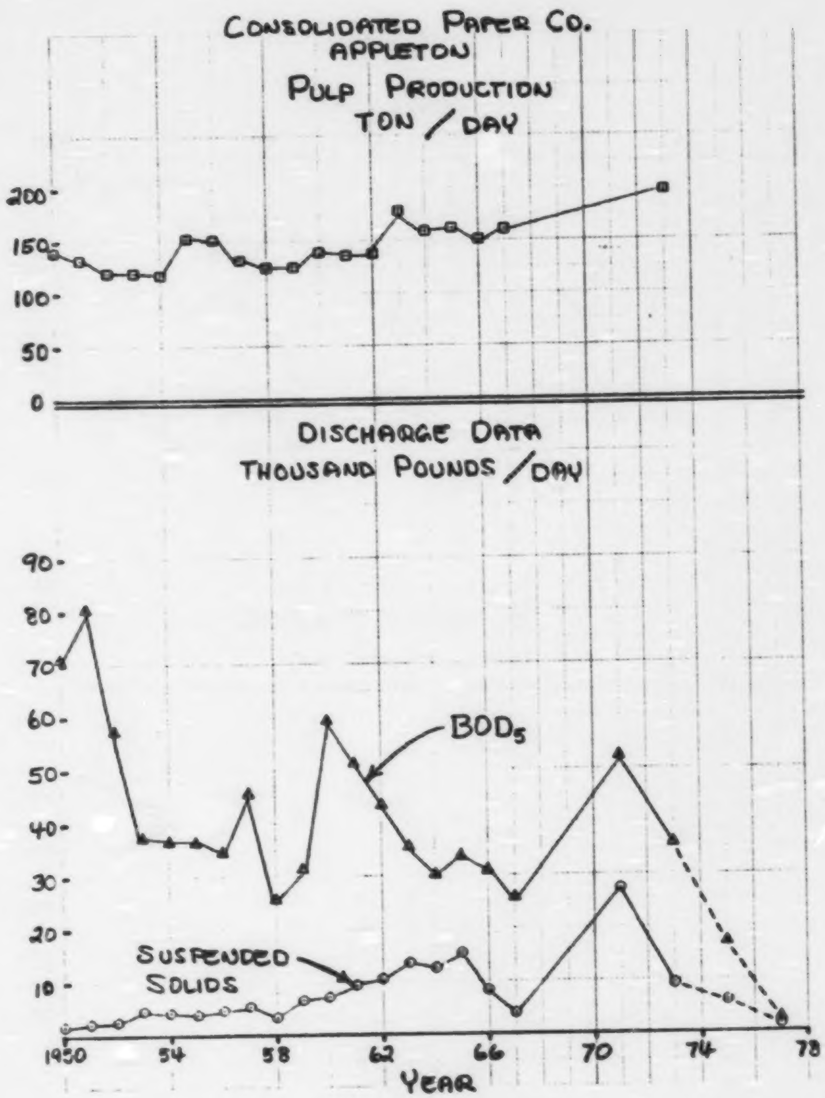

FT. HOWARD PAPER CO.
GREEN BAY
PULP & PAPER PRODUCTION
TON / DAY
1600
1400
1200
1000
800
600
400
200
DISCHARGE DATA
THOUSAND POUNDS / DAY
50
40
30
20
10
BOD5
SUSPENDED SOLIDS
1950
54
58
62
66
70
74
78
YEAR

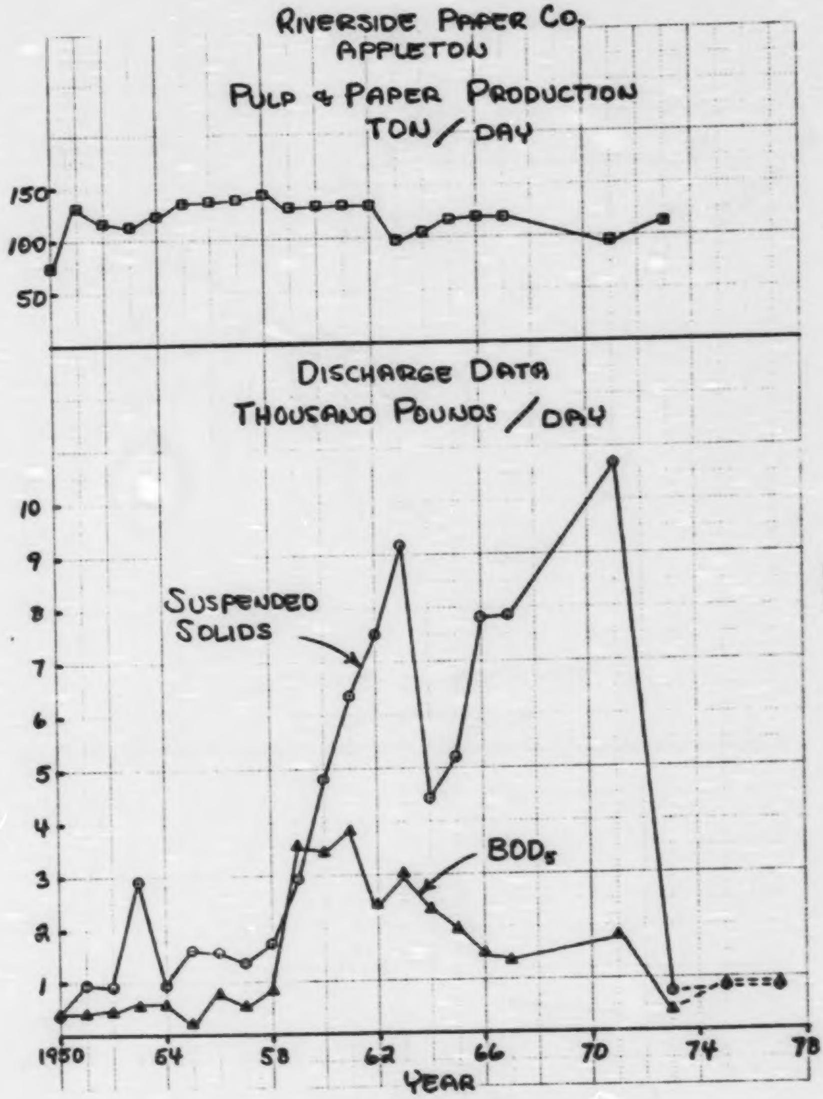

NICOLET PAPER CO.
DE PERE
PAPER PRODUCTION
TON / DAY
200
150
100
50
DISCHARGE DATA
THOUSAND POUNDS / DAY
3.0
2.5
2.0
1.5
1.0
0.5
SUSPENDED SOLIDS
BOD5
1950
54
58
62
66
70
74
78
YEAR

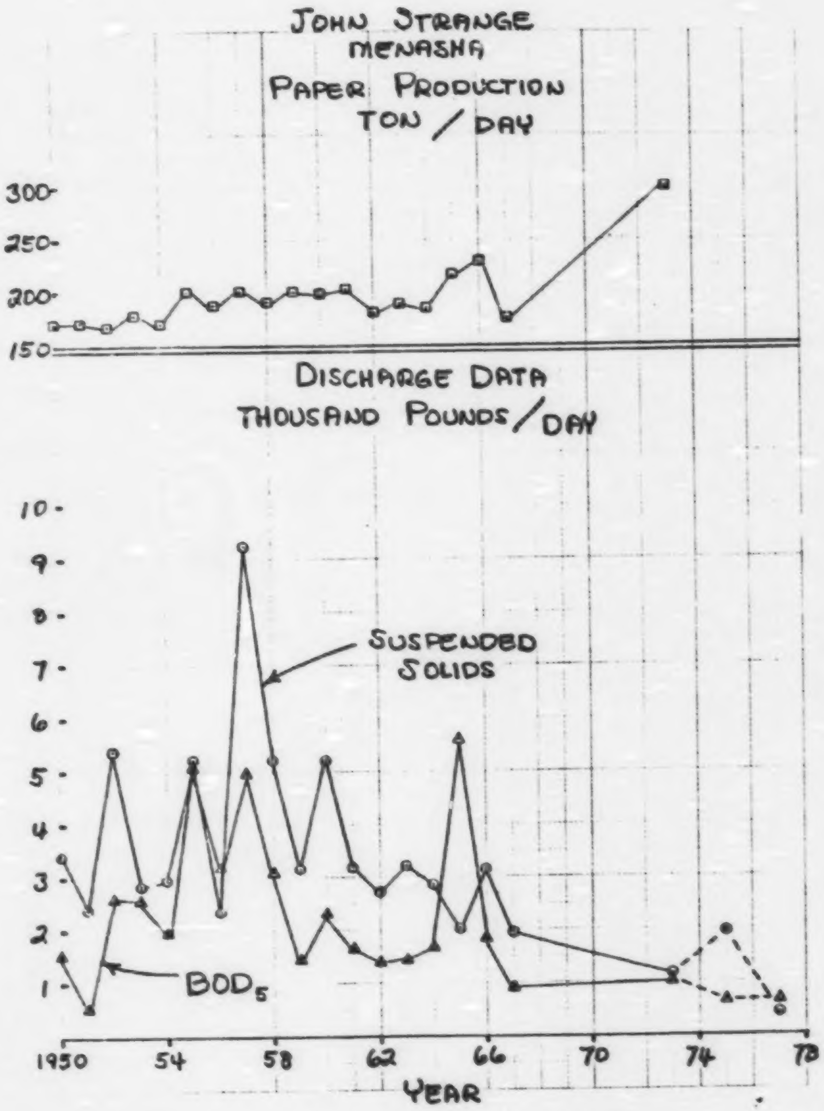

THILMANY PAPER CO.
KAUKAUNA
PULP & PAPER PRODUCTION
TON / DAY
1000
800
600
400
200
DISCHARGE DATA
THOUSAND POUNDS / DAY
80
70
60
50
40
30
20
10
SUSPENDED SOLIDS
BOD5
1950
54
58
62
66
70
74
78
YEAR

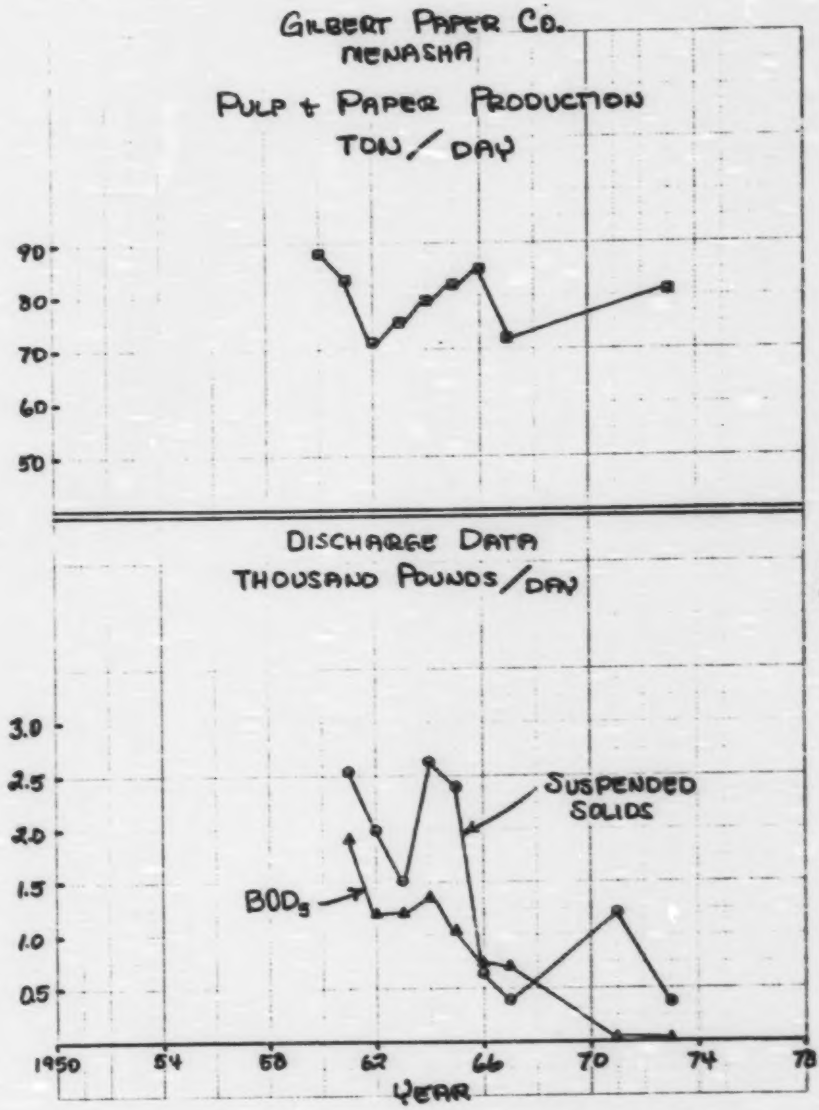

APPLETON PAPERS
COMBINED LOCKS
PULP & PAPER PRODUCTION
TON / DAY
700-
600-
500-
400-
300-
200-
DISCHARGE DATA
THOUSAND POUNDS / DAY
40-
30-
20-
10
SUSPENDED SOLIDS
BOD5
1950
54
58
62
66
70
74
78
YEAR

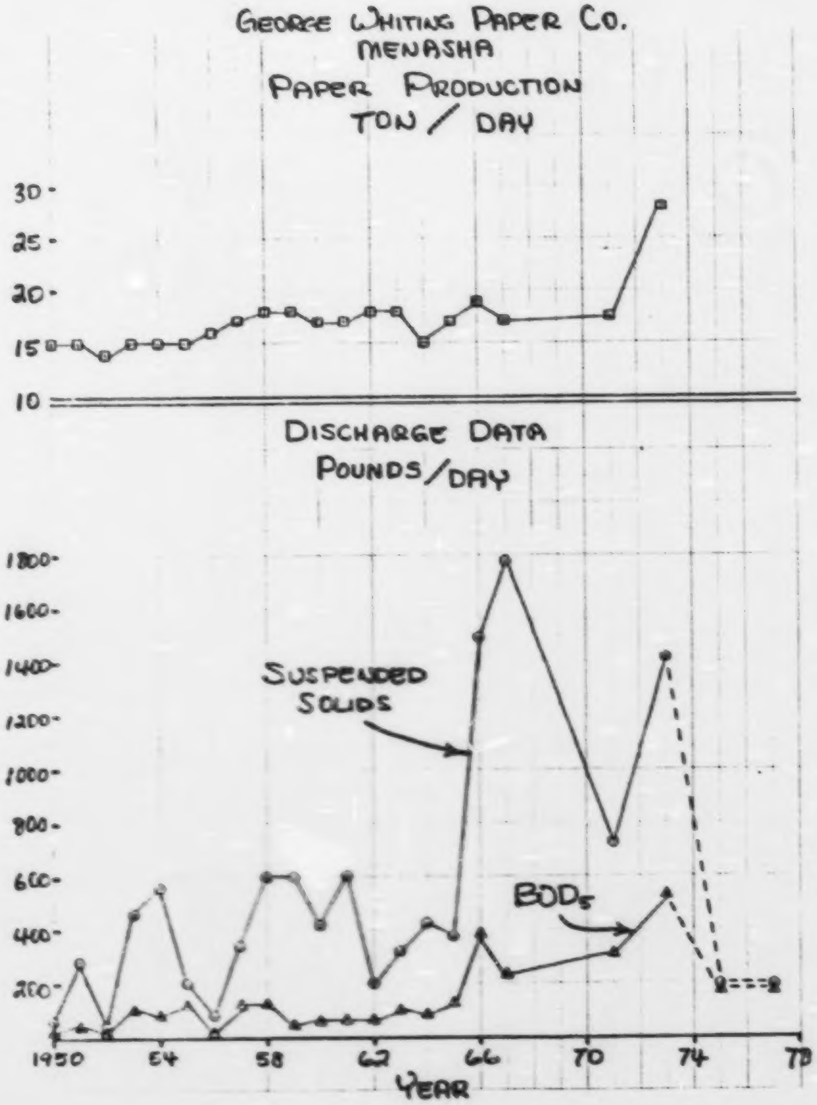

K-C KIMBERLY
PULP & PAPER PRODUCTION
TON / DAY
700
650
600
550
500
450
400
350
DISCHARGE DATA
THOUSAND POUNDS / DAY
80
70
60
50
40
30
20
10
BOD5
SUSPENDED SOLIDS
1950
54
58
62
66
70
74
78
YEAR

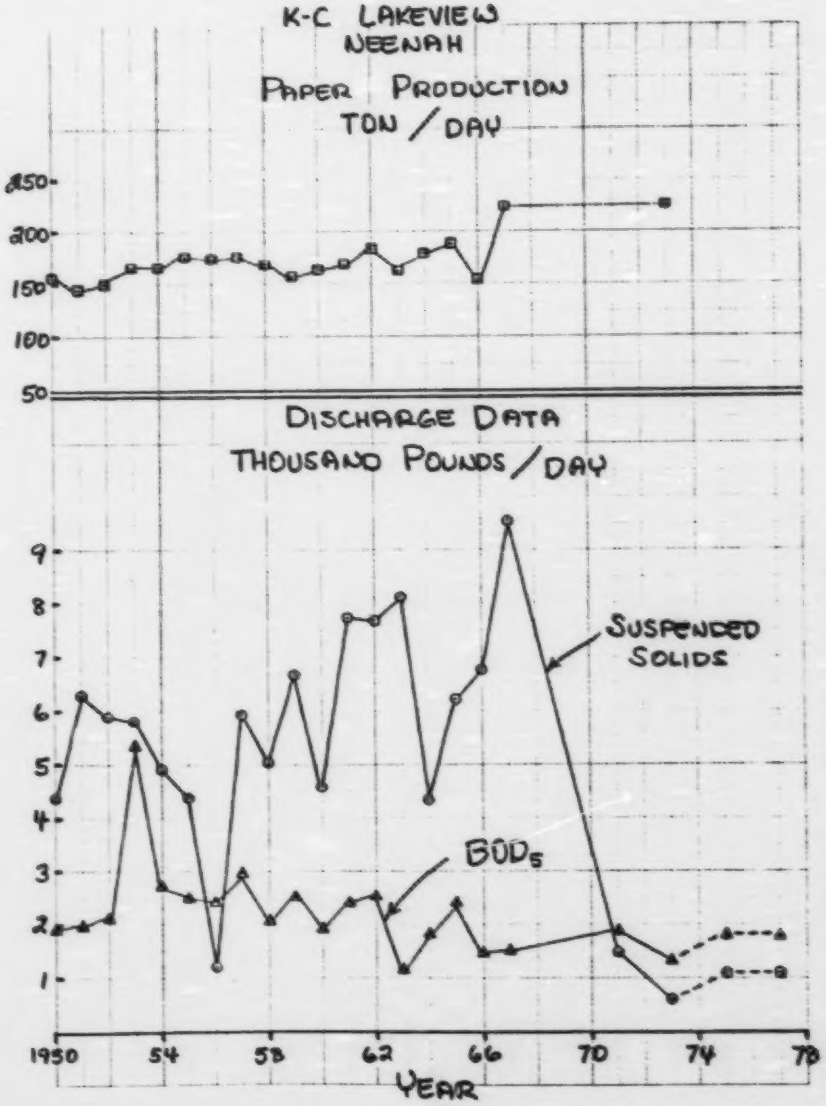

CONSOLIDATED PAPER CO.
APPLETON
PULP PRODUCTION
TON / DAY
200
150
100
50
0
DISCHARGE DATA
THOUSAND POUNDS / DAY
90
80
70
60
50
40
30
20
10
BOD5
SUSPENDED SOLIDS
1950
54
58
62
66
70
74
78
YEAR

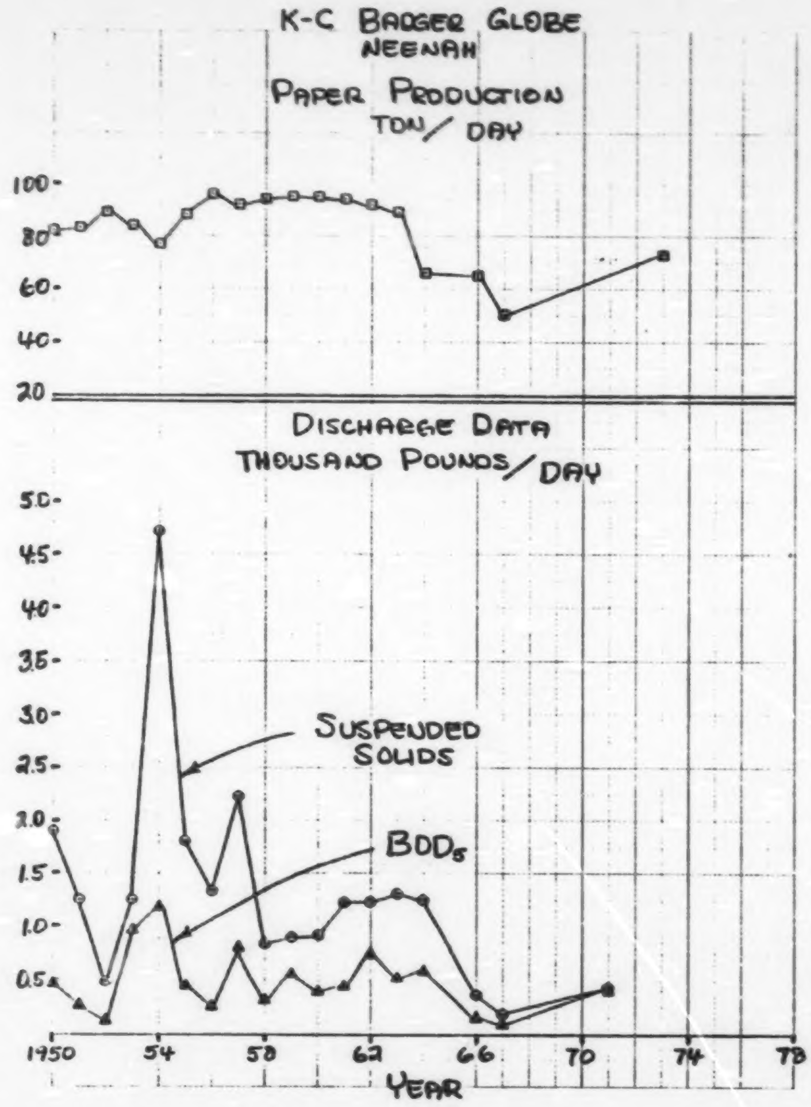

RIVERSIDE PAPER CO.
APPLETON
PULP & PAPER PRODUCTION
TON / DAY
150
100
50
DISCHARGE DATA
THOUSAND POUNDS / DAY
10
9
8
7
6
5
4
3
2
1
SUSPENDED SOLIDS
BOD5
1950
54
58
62
66
70
74
78
YEAR

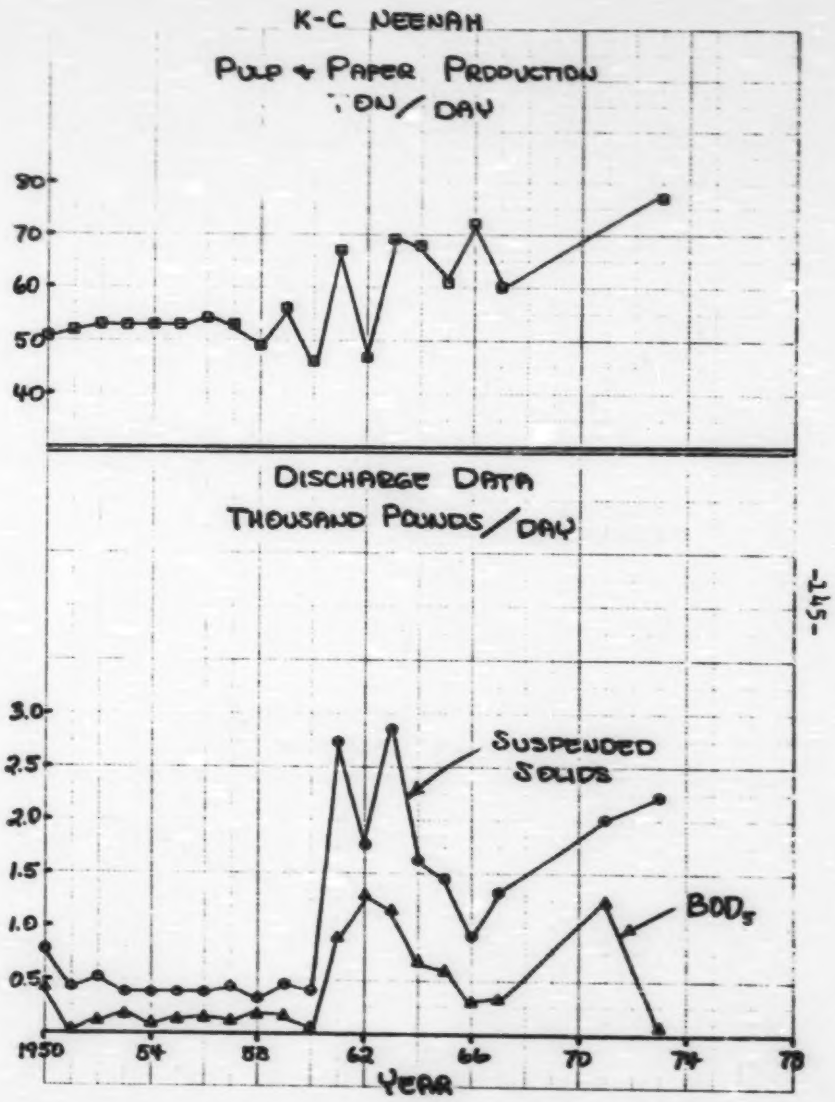

JOHN STRANGE
MENASHA
PAPER PRODUCTION
TON / DAY
300
250
200
150
DISCHARGE DATA
THOUSAND POUNDS / DAY
10
9
8
7
6
5
4
3
2
1
SUSPENDED SOLIDS
BOD5
1950
54
58
62
66
70
74
78
YEAR

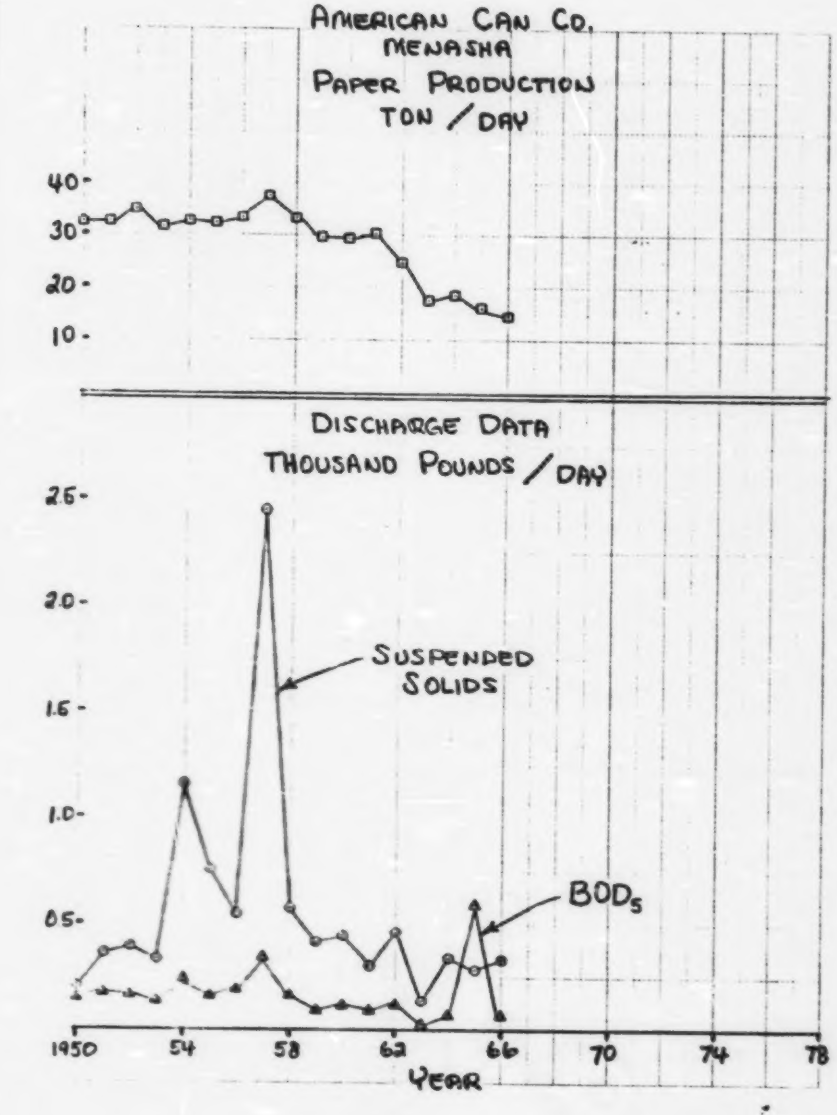

GILBERT PAPER CO.
MENASHA
PULP + PAPER PRODUCTION
TON / DAY
90
80
70
60
50
DISCHARGE DATA
THOUSAND POUNDS / DAY
3.0
2.5
2.0
1.5
1.0
0.5
SUSPENDED SOLIDS
BOD5
1950
54
58
62
66
70
74
78
YEAR

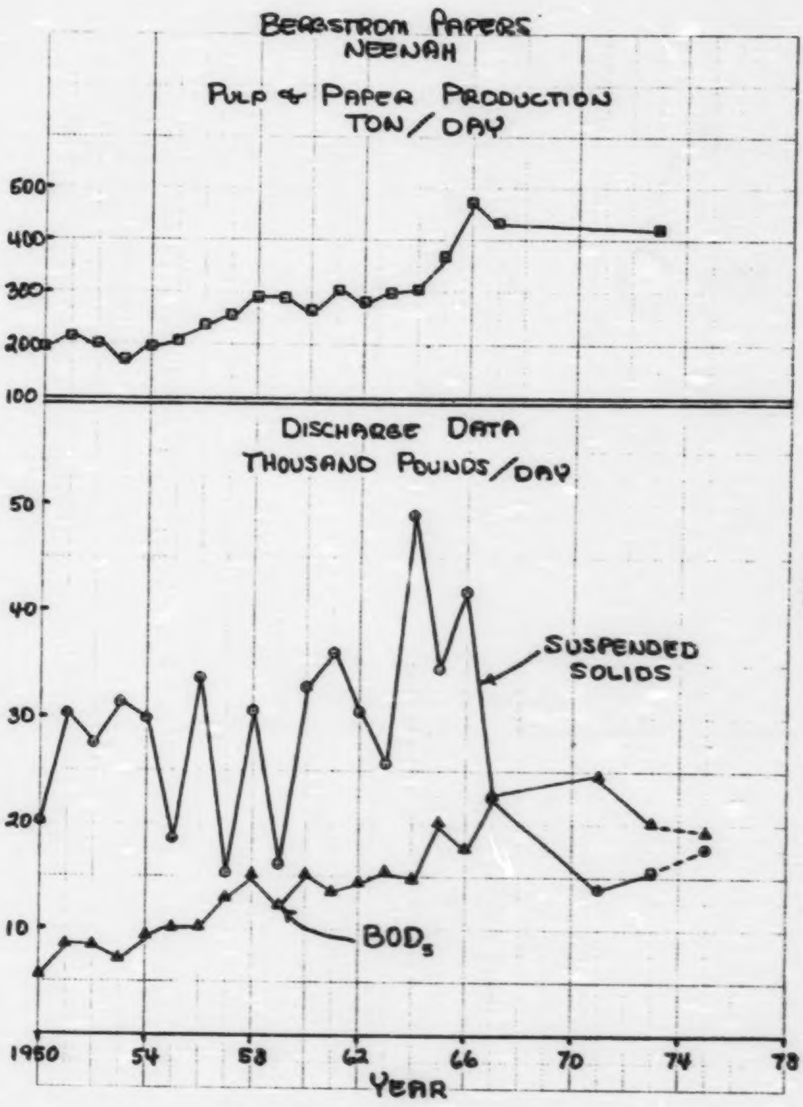

GEORGE WHITING PAPER CO.
MENASHA
PAPER PRODUCTION
TON / DAY
30
25
20
15
10
DISCHARGE DATA
POUNDS/DAY
1800
1600
1400
1200
1000
800
600
400
200
SUSPENDED SOLIDS
BOD5
1950
54
58
62
66
70
74
78
YEAR

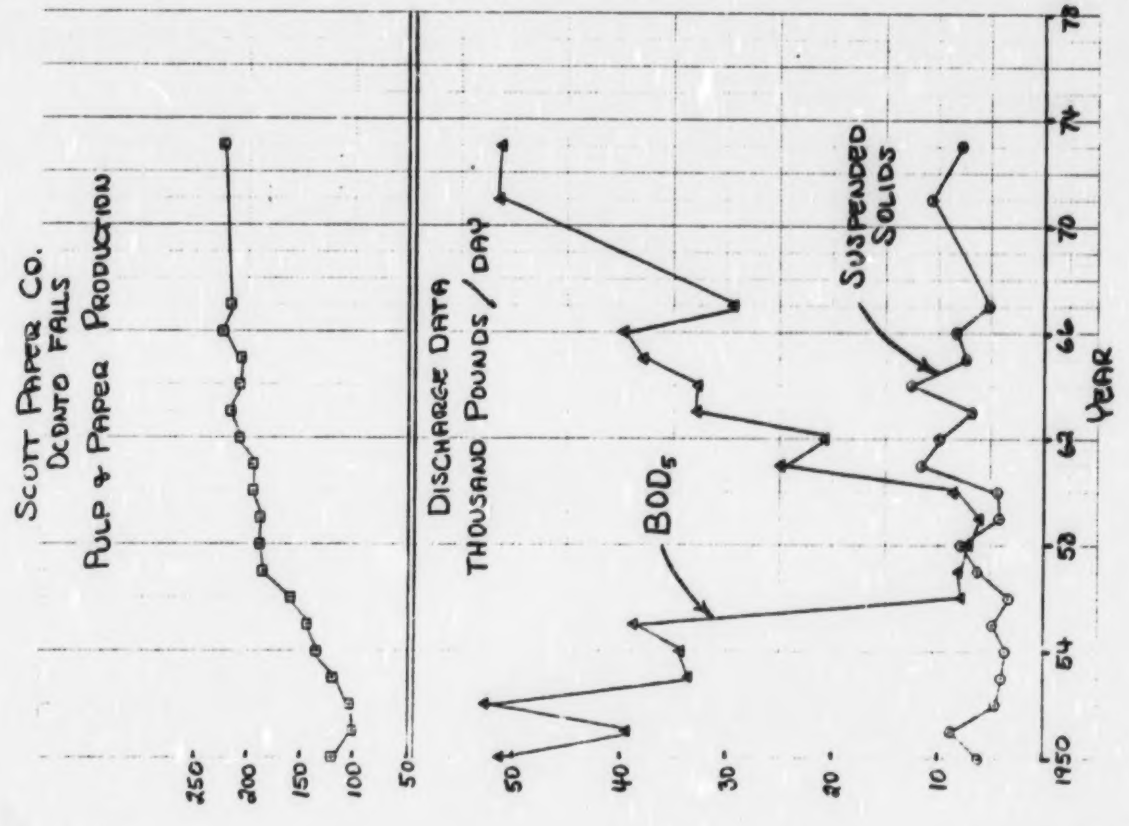

K-C LAKEVIEW
NEENAH
PAPER PRODUCTION
TON / DAY
250
200
150
100
50
DISCHARGE DATA
THOUSAND POUNDS / DAY
9
8
7
6
5
4
3
2
1
SUSPENDED SOLIDS
BOD5
1950
54
58
62
66
70
74
78
YEAR

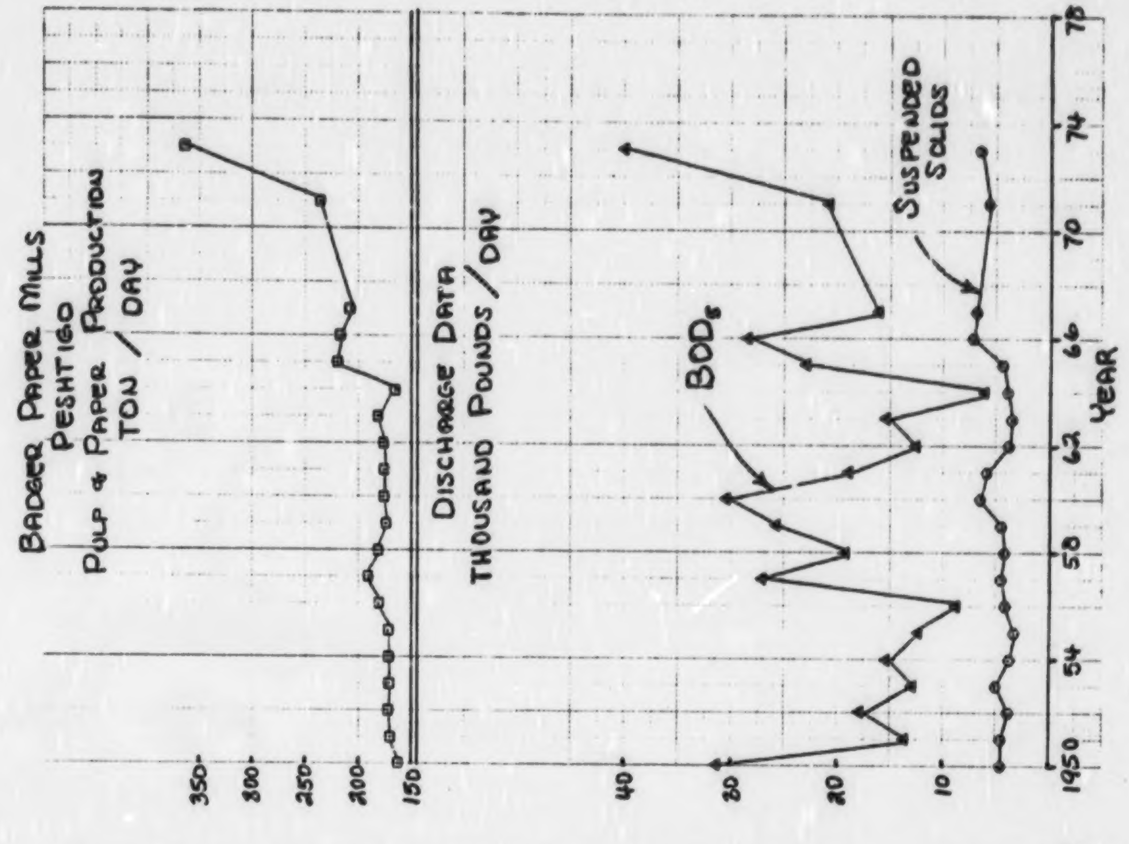

K-C BADGER GLOBE
NEENAH
PAPER PRODUCTION
TON/ DAY
100
80
60
40
20
DISCHARGE DATA
THOUSAND POUNDS/DAY
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
SUSPENDED SOLIDS
BOD_5
1950
54
58
62
66
70
74
78
YEAR

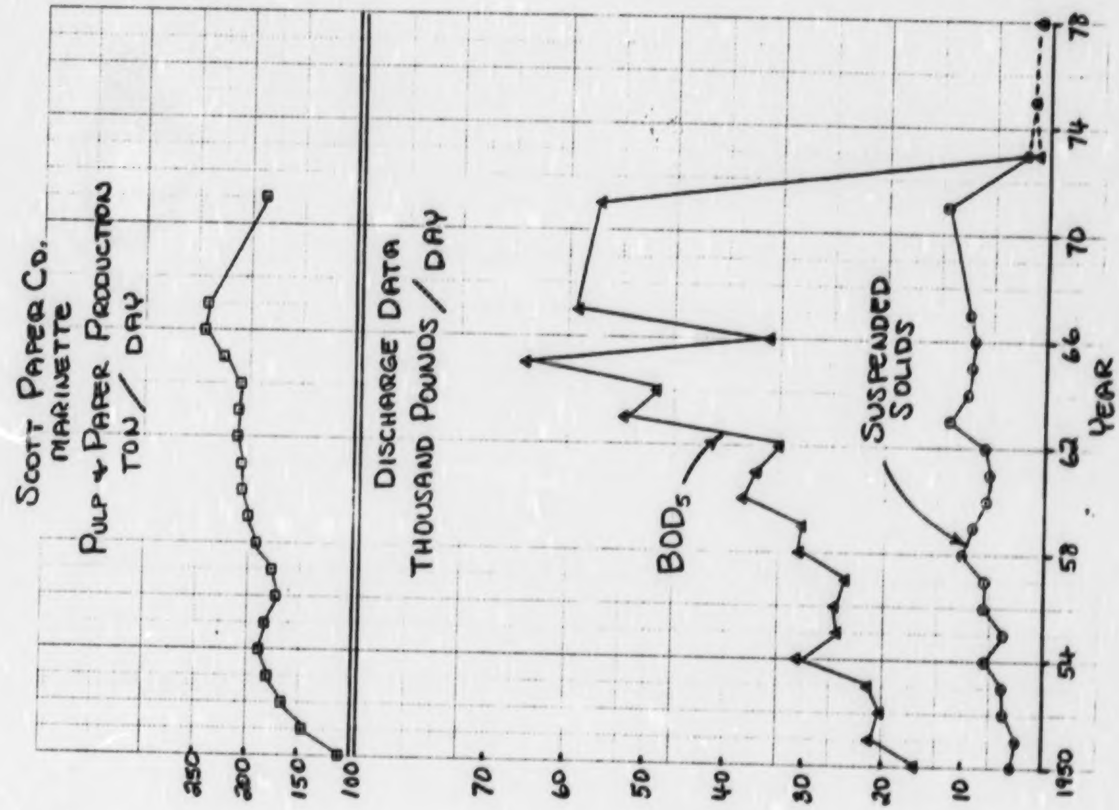

K-C NEENAH
PULP + PAPER PRODUCTION
TON/ DAY
80
70
60
50
40
DISCHARGE DATA
THOUSAND POUNDS/DAY
3.0
2.5
2.0
1.5
1.0
0.5
SUSPENDED SOLIDS
BOD_5
1950
54
58
62
66
70
74
78
YEAR


AMERICAN CAN CO.
MENASHA
PAPER PRODUCTION
TON / DAY
40
30
20
10
DISCHARGE DATA
THOUSAND POUNDS / DAY
2.5
2.0
1.5
1.0
0.5
SUSPENDED SOLIDS
BOD$_5$
1950
54
58
62
66
70
74
78
YEAR


BERGSTROM PAPERS
NEENAH
PULP & PAPER PRODUCTION
TON / DAY
500
400
300
200
100
DISCHARGE DATA
THOUSAND POUNDS / DAY
50
40
30
20
10
SUSPENDED SOLIDS
BOD$_5$
1950
54
58
62
66
70
74
78
YEAR


SCOTT PAPER CO.
OCONTO FALLS
PULP & PAPER PRODUCTION
250
200
150
100
50
DISCHARGE DATA
THOUSAND POUNDS / DAY
BOD5
SUSPENDED SOLIDS
50
40
30
20
10
1950
54
58
62
66
70
74
78
YEAR


BADGER PAPER MILLS
PESHTIGO
PULP & PAPER PRODUCTION
TON / DAY
350
300
250
200
150
DISCHARGE DATA
THOUSAND POUNDS / DAY
BOD5
SUSPENDED SOLIDS
40
30
20
10
1950
54
58
62
66
70
74
78
YEAR


SCOTT PAPER CO.
MARINETTE
PULP + PAPER PRODUCTION
TON / DAY
250
200
150
100
DISCHARGE DATA
THOUSAND POUNDS / DAY
70
60
50
40
30
20
10
BOD$_5$
SUSPENDED SOLIDS
1950
54
58
62
66
70
74
78
YEAR

APPENDIX II.

LOWER FOX, OCONTO, PESHTIGO AND MENOMINEE RIVERS - PRESENT AND PROPOSED WASTE TREATMENT FACILITIES, PULP AND PAPER MILLS

APPENDIX

LOWER FOX RIVER

Green Bay Packaging, Inc. - Green Bay

Waste abatement facilities include internal controls and an evaporation and burn system. A reverse osmosis system is planned to be operational in 1975 with the ultimate goal for a complete recycle program.

Charmin Paper Company - Green Bay

Currently has internal treatment through the use of savealls, a clarifier for water treatment and air scrubber solids, and an evaporation and burn system for concentrated pulp mill liquors. Company proposes to divert residual pulp mill wastes to the Green Bay Metro treatment plant by October 1, 1975.

American Can Company - Green Bay

Present facilities include dual primary settling lagoons for paper mill wastes and an evaporation and burn system for concentrated pulp mill wastes. By October 1, 1975, will divert residual pulp mill wastes to the Green Bay Metro treatment plant.

Ft. Howard Paper Company - Green Bay

Secondary biological treatment is now in operation.

Nicolet Paper Company - De Pere

Treatment includes duplicate primary clarification in addition to sludge dewatering.

Thilmany Pulp and Paper Division - Kaukauna Hammermill Paper Company

Presently has primary clarification plus polishing ponds for paper mill wastes and an aeration lagoon plus polishing pond for pulp mill wastes. Investigating alternatives for improved secondary treatment to meet proposed EPA effluent guidances by July 1, 1977. Has also requested an adjudicatory hearing from the Department of Natural Resources for review of the guidance limitations in the issued permit.

Appleton Papers - Combined Locks

Treatment includes duplicant primary clarifiers plus evaporation and burning for concentrated pulp mill wastes. Now investigating secondary biological treatment to meet EPA proposed effluent guidances by January 1, 1977.

Kimberly - Clark - Kimberly

Has duplicate primary clarifiers and sludge dewatering. Currently investigating secondary biological treatment in order to meet proposed EPA effluent guidances by July 1, 1977.

Consolidated Paper Company - Appleton

Evaporation and burn system for concentrated pulp mill wastes. Internal primary clarification is proposed to be operational by September 1, 1975. Remaining wastes are proposed to be directed to the Appleton municipal treatment plant by July 1, 1977.

Riverside Paper Company - Appleton

Concentrated wastes are diverted to the Appleton municipal treatment plant. Dilute saveall wastes are discharged directly to the Fox River.

John Strange Division - Menasha Corp. - Menasha

Concentrated wastes are now sent to the Neenah - Menasha Metro treatment plant. Diluted wastes diverted to the Fox River. Additional treatment alternatives are being investigated to meet proposed EPA effluent guidances by January 1, 1976.

Gilbert Paper Company - Menasha

All process wastes are presently directed to the Neenah - Menasha Metro treatment plant along with water treatment solids.

George A. Whiting Company - Menasha

Presently provides internal saveall treatment. Proposes to install primary treatment by January 1, 1976 in order to meet proposed EPA effluent guidances.

Kimberly - Clark, Lakeview Mill - Menasha

Currently provides primary clarification plus sludge dewatering.

Kimberly - Clark, Badger Globe Mill - Neenah

All process wastes are directed to the Neenah - Menasha Metro treatment plant.

Kimberly - Clark, Neenah Division

All process wastes directed to the Neenah - Menasha Metro treatment plant. Water treatment plant solids proposed to be diverted to municipal system by August 1, 1974.

Bergstrom Paper Company - Neenah

Present treatment for process wastes consists of a primary clarifier plus sludge dewatering facilities. These effluents are proposed to be diverted to the Neenah - Menasha Metro treatment plant by July, 1976. Company has requested an adjudicatory hearing for review of the Department of Natural Resources issued permit which requires connection to the municipal plant.

OCONTO RIVER

Scott Paper Company - Oconto Falls

Present treatment includes primary clarification for paper and dilute pulp wastes and evaporation and burning and a holding lagoon for concentrated pulp mill wastes. Present plans are for modification of the holding lagoon into a joint municipal-industrial aerated lagoon system to serve the mill and the City of Oconto Falls.

PESHTIGO RIVER

Badger Paper Mills - Peshtigo

Currently has duplicate primary settling lagoons for paper mill wastes and has installed a new evaporation and burn system for concentrated pulp mill wastes. Residual pulp mill wastes are proposed to be diverted to a joint municipal and industrial treatment plant now under construction for the mill and the City of Peshtigo.

MENOMINEE RIVER

Scott Paper Company - Marinette

Existing treatment consists of primary clarification with backup settling lagoon and sludge dewatering. Presently investigating alternatives for improving existing systems to meet proposed EPA effluent guidances by July 1, 1976.

APPENDIX III.

LOWER FOX, OCONTO, PESHTIGO AND MENOMINEE RIVERS - MUNICIPAL SEWAGE TREATMENT PLANT RIVER LOADINGS, 1948-1978

GREEN BAY METRO
SEWAGE TREATMENT PLANT
EFFLUENT DATA

Year	Discharge MGD	BOD$_5$		Suspended Solids		KJEL-N	
		lb/day	Kg/day	lb/day	Kg/day	lb/day	Kg/day
1946	9.395	12,002	5,443	7,845	3,558	-	-
1947	8.029	11,799	5,351	6,570	2,980	-	-
1948	9.053	12,019	5,451	7,635	3,462	-	-
1949	8.643	12,846	5,826	7,145	3,240	-	-
1950	8.670	14,262	6,468	6,877	3,119	-	-
1951	9.046	12,916	5,858	8,082	3,665	-	-
1952	12.119	12,750	5,782	10,625	4,819	-	-
1953	11.370	15,000	6,803	11,772	5,339	-	-
1954	10.011	15,381	6,975	10,198	4,625	-	-
1955	11.205	15,438	7,001	11,227	5,092	-	-
1956	10.053	6,967	3,160	6,548	2,969	-	-
1957	10.593	8,137	3,690	7,076	3,209	-	-
1958	11.794	9,651	4,377	8,371	3,796	-	-
1959	10.602	9,738	4,416	7,879	3,573	-	-
1960	12.450	10,084	4,573	8,317	3,772	-	-
1961	13.358	11,265	5,109	9,704	4,401	-	-
1962	13.952	11,533	5,231	9,902	4,491	-	-
1966	13.500	16,200	7,347	-	-	-	-
1970	19.060	21,128	9,582	12,079	5,478	-	-
('70 raw bypass)	0.830	1,816	824	1,580	716	-	-
1971	-	-	-	-	-	3,700	1,678
1972	20.010	22,545	10,224	13,838	6,276	3,535	1,603
('72 raw bypass)	1.640	3,780	1,714	3,232	1,466	-	-
1973	20.910	19,600	8,889	13,708	6,217	-	-
('73 raw bypass)	4.170	8,461	3,837	7,068	3,205	-	-
1975 (Mar. 31)	-	32,100	14,558	23,950	10,862	-	-
1978 (Dec. 31)	-	13,105	5,943	12,105	5,490	-	-

Year	NH$_3$-N		NO$_2$+NO$_3$-N		Total-P		Sol.-P	
	lb/day	Kg/day	lb/day	Kg/day	lb/day	Kg/day	lb/day	Kg/day
1971	2,730	1,238	150	68	1,803	491	770	349
1972	2,029	920	20	9	-	-	-	-
1973	-	-	-	-	1,385	628	296	134

DEPERE, CITY
SEWAGE TREATMENT PLANT
EFFLUENT DATA

Year	Discharge MGD	BOD$_5$ lb/day	BOD$_5$ Kg/day	Suspended Solids lb/day	Suspended Solids Kg/day	KJEL-N lb/day	KJEL-N Kg/day
1948	-	600	272	440	200	-	-
1956	1.090	764	346	646	293	-	-
1966	1.500	1,065	483	-	-	-	-
1971	2.204	1,546	701	-	-	1,070	485
1972	2.282	1,486	674	1,296	588	1,280	580
('72 raw bypass)	9.211	23,073	10,464	15,921	7,220	-	-
1973	2.652	1,076	488	1,032	468	-	-
('73 raw bypass)	1.125	2,452	1,112	2,038	924	-	-
1977 (June, 30)		2,160	985	2,160	985	-	-
1979 (June, 30)	To be based on future design flow.						

Year	NH_3-N lb/day	NH_3-N Kg/day	NO_2+NO_3-N lb/day	NO_2+NO_3-N Kg/day	Total-P lb/day	Total-P Kg/day	Sol.-P lb/day	Sol.-P Kg/day
1971	436	198	21	10	144	65	128	58
1972	531	241	<1.9	<1.0	-	-	-	-
1973	-	-	-	-	58	26	22	10

WRIGHTSTOWN, VILLAGE
SEWAGE TREATMENT PLANT
EFFLUENT DATA

Year	Discharge MGD	BOD5 lb/day	BOD5 Kg/day	Suspended Solids lb/day	Suspended Solids Kg/day	KJEL-N lb/day	KJEL-N Kg/day
1956	0.090	784	356	118	54	-	-
1966	0.090	40	18	-	-	-	-
1971	0.189	-	-	-	-	25	11
1972	0.156	-	-	-	-	-	-
1973	0.170	56	26	55	25	-	-
1977 (Mar. 31)	-	83	38	83	38	-	-

Year	NH_3-N lb/day	NH_3-N Kg/day	NO_2+NO_3-N lb/day	NO_2+NO_3-N Kg/day	Total-P lb/day	Total-P Kg/day	Sol.-P lb/day	Sol.-P Kg/day
1971	15	7	4	2	9	4	7	3

KAUKAUNA, CITY
SEWAGE TREATMENT PLANT
EFFLUENT DATA

Year	Discharge MGD	BOD$_5$		Suspended Solids		KJEL-N	
		lb/day	Kg/day	lb/day	Kg/day	lb/day	Kg/day
1948	-	900	408	500	227	-	-
1956	1.590	554	251	370	168	-	-
1966	1.275	255	116	-	-	-	-
1971	1.782	164	74	-	-	561	254
1972	1.769	192	87	490	223	-	-
1973	1.953	245	111	388	176	-	-
1977 (June 30)		640	300	640	300	-	-

After June 30, 1977, plant will either be abandoned or interconnected to the Heart of the Valley Sewerage Commission.

Year	NH_3-N		NO_2+NO_3-N		Total-P		Sol.-P	
	lb/day	Kg/day	lb/day	Kg/day	lb/day	Kg/day	lb/day	Kg/day
1971	59	27	128	58	81	37	56	25
1973	-	-	-	-	18	8	4	2

LITTLE CHUTE, VILLAGE
SEWAGE TREATMENT PLANT
EFFLUENT DATA

Year	Discharge MGD	BOD$_5$		Suspended Solids		KJEL-N	
		lb/day	Kg/day	lb/day	Kg/day	lb/day	Kg/day
1948	-	400	181	220	100	-	-
1956	0.390	598	271	344	156	-	-
1967	0.403	167	76	-	-	-	-
1971	-	-	-	-	-	85	38
1972	0.594	174	79	-	-	-	-
1973	0.812	164	74	-	-	-	-
1977 (June 30)		260	120	260	120	-	-

Year	NH_3-N		NO_2+NO_3-N		Total-P		Sol.-P	
	lb/day	Kg/day	lb/day	Kg/day	lb/day	Kg/day	lb/day	Kg/day
1971	47	21	13	6	35	16	24	11

KIMBERLY, VILLAGE
SEWAGE TREATMENT PLANT
EFFLUENT DATA

Year	Discharge MGD	BOD$_5$ lb/day	BOD$_5$ Kg/day	Suspended Solids lb/day	Suspended Solids Kg/day	KJEL-N lb/day	KJEL-N Kg/day
1948	-	80	36	60	27	-	-
1956	0.310	32	14	16	7	-	-
1967	0.359	90	41	-	-	-	-
1971	-	-	-	-	-	174	79
1972	0.548	-	-	-	-	-	-
1973	0.544	196	89	92	42	-	-
1977 (June 30)		250	115	250	115	-	-

Year	NH$_3$-N lb/day	NH$_3$-N Kg/day	NO$_2$+NO$_3$-N lb/day	NO$_2$+NO$_3$-N Kg/day	Total-P lb/day	Total-P Kg/day	Sol.-P lb/day	Sol.-P Kg/day
1971	114	52	13	6	44	20	32	14
1973	-	-	-	-	13	6	1	$<$1.0

APPLETON, CITY
SEWAGE TREATMENT PLANT
EFFLUENT DATA

Year	Discharge MGD	BOD$_5$ lb/day	BOD$_5$ Kg/day	Suspended Solids lb/day	Suspended Solids Kg/day	KJEL-N lb/day	KJEL-N Kg/day
1948	-	7,800	3,537	3,060	1,388	-	-
1956	7.630	9,876	4,479	4,850	2,200	-	-
1966	8.339	5,890	2,671	-	-	-	-
1971	11.610	4,168	1,890	3,587	1,627	2,210	1,002
1972	12.100	3,634	1,648	3,379	1,532	1,419	644
1973	14.020	4,612	2,092	6,181	2,803	-	-
*('73 secondary bypass)	2.040	3,540	1,605	1,920	871	-	-
1977 (June 30)		8,250	3,741	13,750	6,236	-	-
*('77 bypass)		10,800	4,898	6,770	3,070	-	-
1978 to be determined from 1977 design flow.							

Year	NH$_3$-N lb/day	NH$_3$-N Kg/day	NO$_2$+NO$_3$-N lb/day	NO$_2$+NO$_3$-N Kg/day	Total-P lb/day	Total-P Kg/day	Sol.-P lb/day	Sol.-P Kg/day
1971	703	319	96	44	378	171	284	129
1972	1,119	508	13	6	-	-	-	-
1973	-	-	-	-	206	93	-	-

*Indicates bypass following primary treatment.

MENASHA, TOWN
SANITARY DISTRICT # 4, EAST PLANT
SEWAGE TREATMENT PLANT
EFFLUENT DATA

Year	Discharge MGD	BOD_5		Suspended Solids		KJEL-N	
		lb/day	Kg/day	lb/day	Kg/day	lb/day	Kg/day
1967	0.465	140	63	-	-	-	-
1971	0.659	44	20	-	-	217	98
1972	0.689	102	46	44	20	-	-
1973	0.618	79	36	92	42	-	-
1979 (Mar. 31)		390	175	390	175	-	-

Year	NH_3-N		NO_2+NO_3-N		Total-P		Sol.-P	
	lb/day	Kg/day	lb/day	Kg/day	lb/day	Kg/day	lb/day	Kg/day
1971	[illegible]8	49	26	12	106	48	36	16
1973		-	-	-	15	7	2.7	1.2

MENASHA, TOWN - SANITARY DISTRICT # 4, WEST PLANT
SEWAGE TREATMENT PLANT EFFLUENT DATA

Year	Discharge MGD	BOD_5		Suspended Solids	
		lb/day	Kg/day	lb/day	Kg/day
1972	1.098	-	-	-	-
1973	0.741	33	15	9	4
1979 (Mar. 31)		250	113	250	113

NEENAH-MENASHA SEWERAGE COMMISSION
SEWAGE TREATMENT PLANT
EFFLUENT DATA

Year	Discharge MGD	BOD_5		Suspended Solids		KJEL-N	
		lb/day	Kg/day	lb/day	Kg/day	lb/day	Kg/day
1947	13.071	15,940	7,229	29,160	13,224	-	-
('47 raw bypass)	0.500	960	435	2,880	1,306	-	-
1956	9.200	7,142	3,239	4,836	2,193	-	-
1966	16.000	2,080	943	-	-	-	-
1971	14.700	2,455	1,113	10,065	4,565	2,160	980
1972	16.300	6,941	3,148	24,635	11,172	326	148
1973	14.960	4,097	1,858	14,116	6,402	-	-
1976 (June 30)	-	9,000	4,082	22,520	10,213	-	-
1978 (Dec. 31)	-	10,000	4,535	10,000	4,535	-	-

Year	NH_3-N		NO_2+NO_3-N		Total-P		Sol.-P	
	lb/day	Kg/day	lb/day	Kg/day	lb/day	Kg/day	lb/day	Kg/day
1971	196	89	146	66	214	97	80	36
1972	70	32	20*	9	-	-	-	-
1973	-	-	-	-	225	102	-	-

*NO_3-N only.

OCONTO, CITY
SEWAGE TREATMENT PLANT
EFFLUENT DATA

Year	Discharge MGD	BOD5		Suspended Solids		KJEL-N	
		lb/day	Kg/day	lb/day	Kg/day	lb/day	Kg/day
1953	Under construction	-	-	-	-	-	-
1961	0.938	225	102	-	-	-	-
1968	1.449	845	383	-	-	96	44
1971	1.330	355	161	-	-	-	-
1972	1.054	361	164	-	-	-	-
1973	1.446	126	57	266	121	43	20

Year	NH_3-N		NO_2+NO_3-N		Total-P		Sol.-P	
	lb/day	Kg/day	lb/day	Kg/day	lb/day	Kg/day	lb/day	Kg/day
1968	11	5	5	2	48	22	-	-
1973	19	9	22	10	12	5	1.2	<1.0

OCONTO FALLS, CITY
SEWAGE TREATMENT PLANT
EFFLUENT DATA

Year	Discharge MGD	BOD5		Suspended Solids		KJEL-N	
		lb/day	Kg/day	lb/day	Kg/day	lb/day	Kg/day
1953	0.179	42	19	-	-	-	-
1961	0.200	100	45	-	-	-	-
1968	0.220	105	48	-	-	60	27
1971	0.210	-	-	-	-	-	-
1972	0.194	-	-	-	-	-	-
1973	0.239	61	28	57	26	27	12

Year	NH_3-N		NO_2+NO_3-N		Total-P		Sol.-P	
	lb/day	Kg/day	lb/day	Kg/day	lb/day	Kg/day	lb/day	Kg/day
1968	44	24	<1.0	<1.0	20	9	15	7
1973	20	9	11	5	5	2	4	2

GILLETT, CITY
SEWAGE TREATMENT PLANT EFFLUENT DATA

Year	Discharge MGD	BOD5		Suspended Solids		KJEL-N	
		lb/day	Kg/day	lb/day	Kg/day	lb/day	Kg/day
1953	0.106	50	23	-	-	-	-
1961	0.105	46	21	-	-	-	-
1968	0.227	11	5	-	-	23	10
1971	0.189	139	63	-	-	-	-
1972	0.165	123	56	-	-	-	-
1973	0.182	44	20	29	13	8	3.6

Year	NH_3-N		NO_2+NO_3-N		Total-P		Sol.-P	
	lb/day	Kg/day	lb/day	Kg/day	lb/day	Kg/day	lb/day	Kg/day
1968	18	8	<1.0	<1.0	11	5	6	3
1973	5	2	11	5	9	4	7	3

PESHTIGO, CITY
SEWAGE TREATMENT PLANT
EFFLUENT DATA

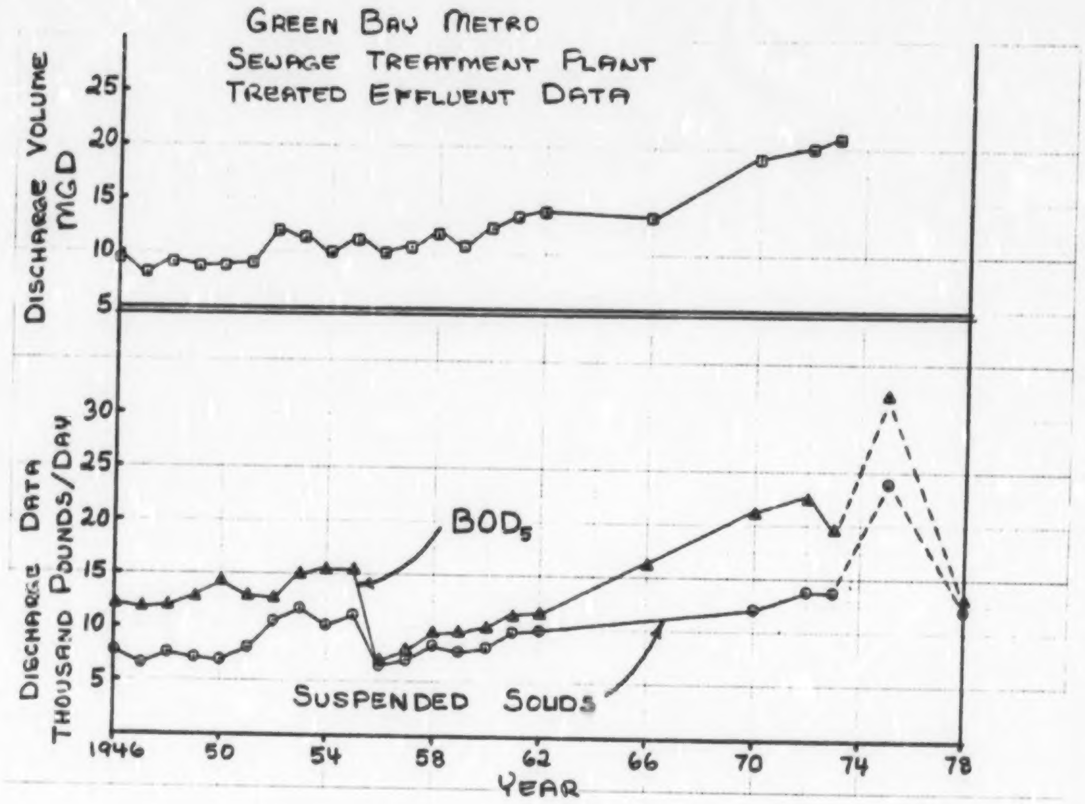
Year	Discharge MGD	BOD5		Suspended Solids		KJEL-N	
		lb/day	Kg/day	lb/day	Kg/day	lb/day	Kg/day
1953	0.674	155	70	-	-	-	-
1961	0.525	155	70	-	-	-	-
1968	0.559	205	93	-	-	65	29
1971	0.490	172	78	-	-	-	-
1972	0.477	175	79	-	-	-	-
1973	0.487	138	63	84	38	37	17

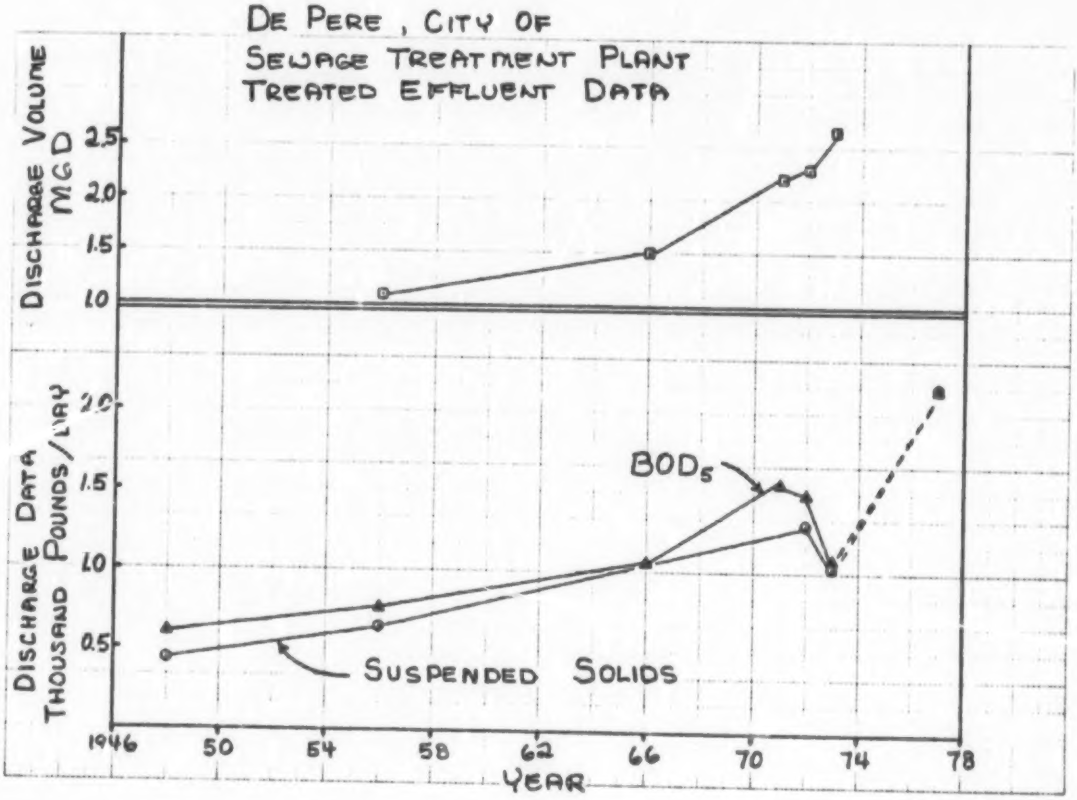
Year	NH_3-N		NO_2+NO_3-N		Total-P		Sol.-P	
	lb/day	Kg/day	lb/day	Kg/day	lb/day	Kg/day	lb/day	Kg/day
1968	38	17	<1.0	<1.0	27	12	16	7
1973	18	8	3	1.5	19	9	9	4

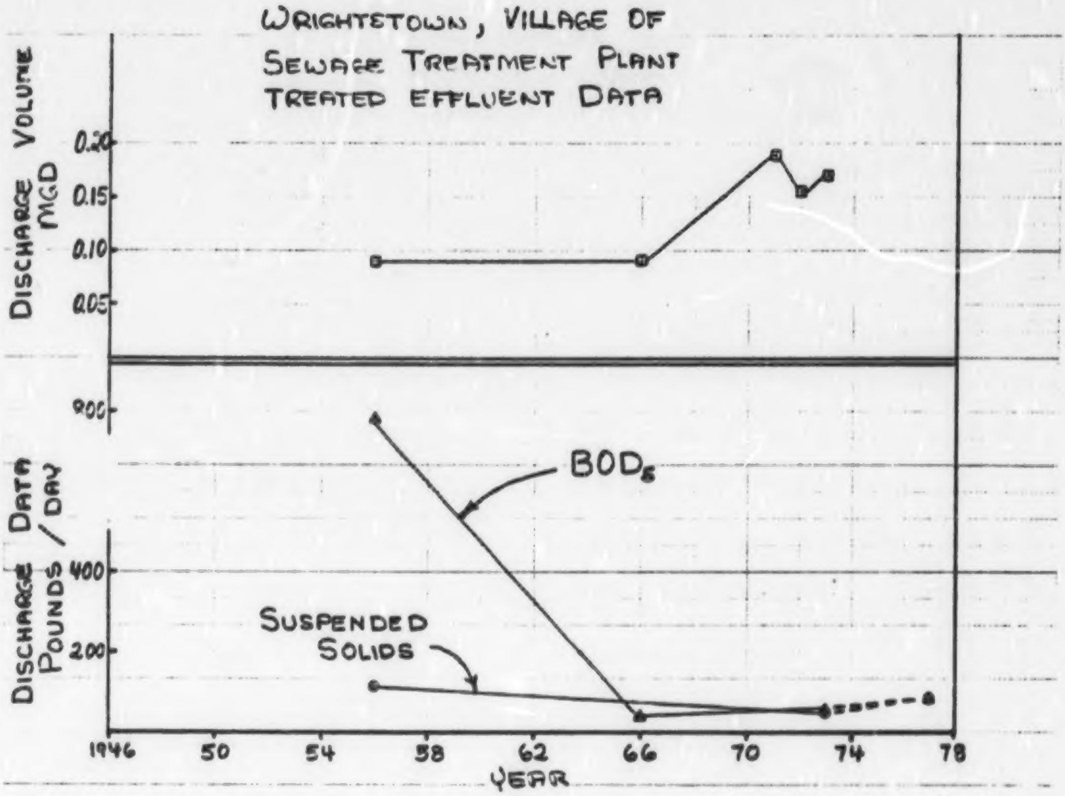
MARINETTE, CITY
SEWAGE TREATMENT PLANT
EFFLUENT DATA

Year	Discharge MGD	BOD5		Suspended Solids		KJEL-N	
		lb/day	Kg/day	lb/day	Kg/day	lb/day	Kg/day
1953	3.080	2,000	907	-	-	-	-
1961	3.000	1,670	757	-	-	-	-
1968	2.169	1.230	558	-	-	401	182
1971	3.060	-	-	-	-	-	-
1973	3.762	327	148	547	248	73	33

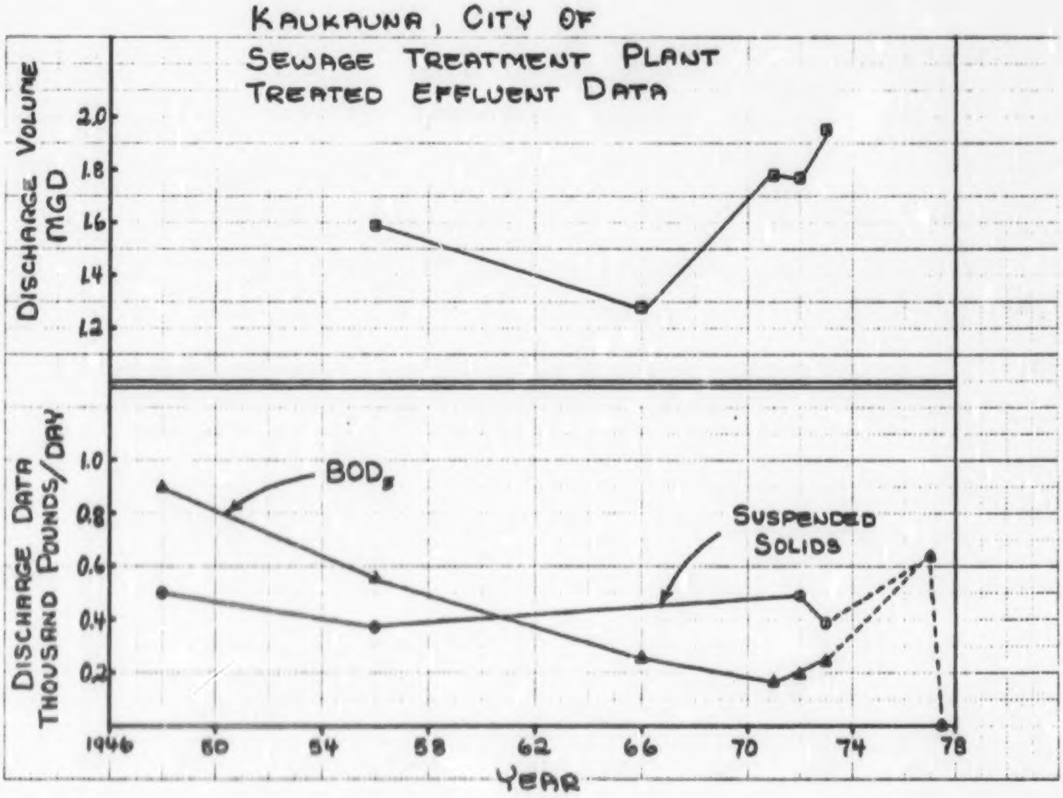
Year	NH_3-N		NO_2+NO_3-N		Total-P		Sol.-P	
	lb/day	Kg/day	lb/day	Kg/day	lb/day	Kg/day	lb/day	Kg/day
1968	196	89	< 7	<3	141	64	72	33
1973	13	6	76	34	31	14	18	8


GREEN BAY METRO
SEWAGE TREATMENT PLANT
TREATED EFFLUENT DATA
DISCHARGE VOLUME MGD
5
10
15
20
25
DISCHARGE DATA THOUSAND POUNDS/DAY
5
10
15
20
25
30
BOD5
SUSPENDED SOLIDS
1946
50
54
58
62
66
70
74
78
YEAR

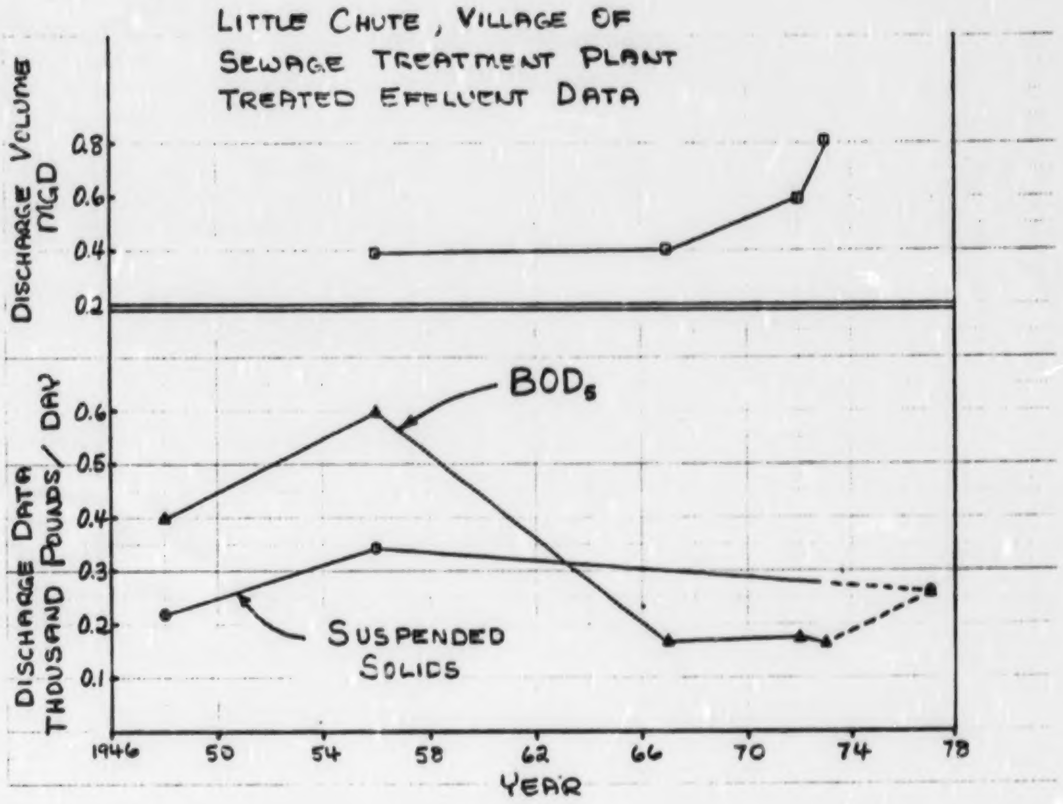

DE PERE, CITY OF
SEWAGE TREATMENT PLANT
TREATED EFFLUENT DATA
DISCHARGE VOLUME MGD
1.0
1.5
2.0
2.5
DISCHARGE DATA THOUSAND POUNDS/DAY
0.5
1.0
1.5
2.0
BOD5
SUSPENDED SOLIDS
1946
50
54
58
62
66
70
74
78
YEAR

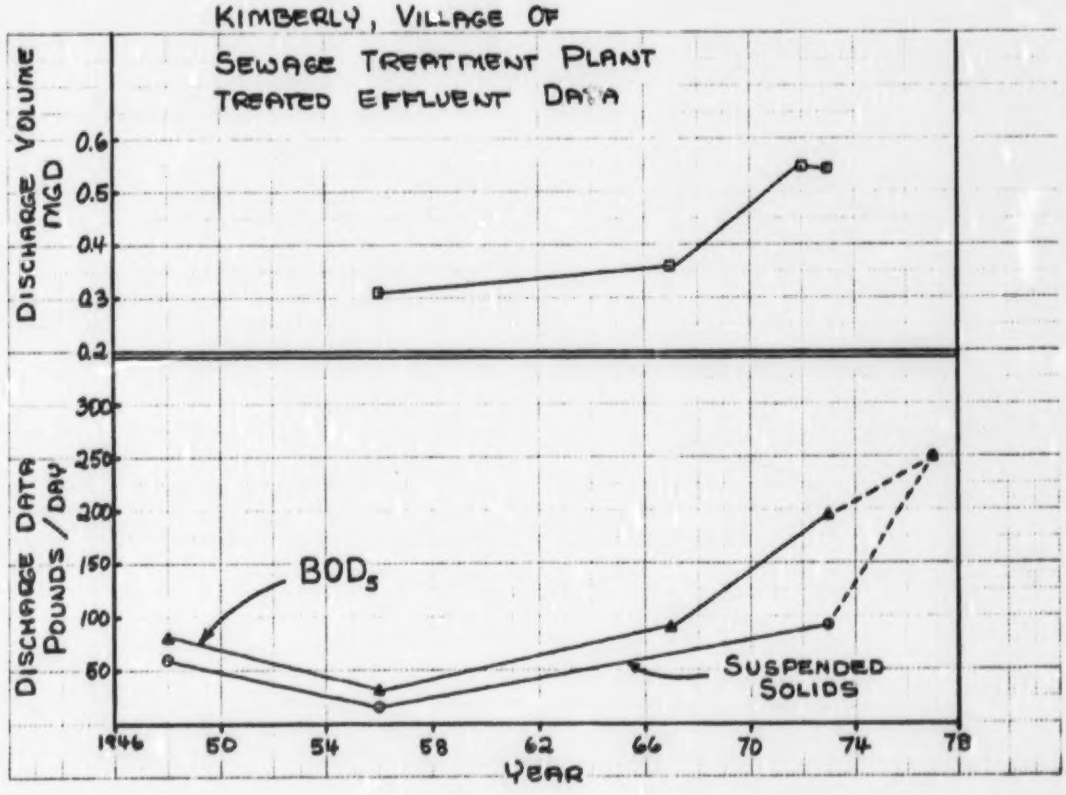


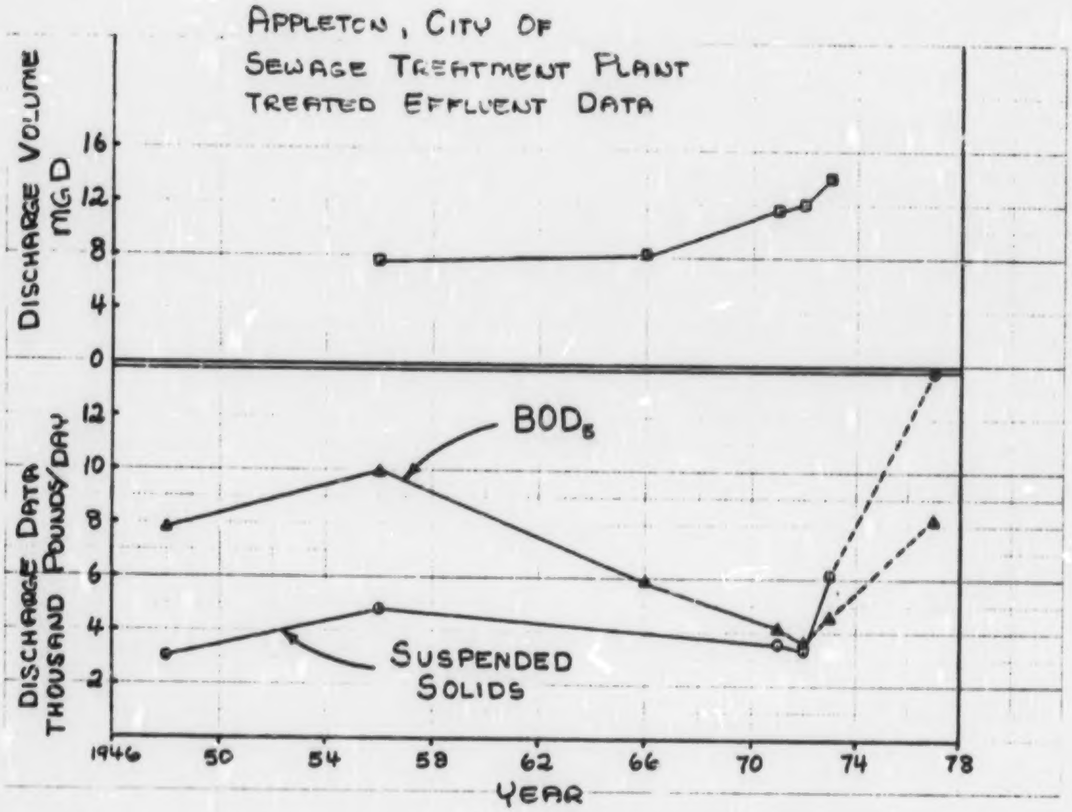
WRIGHTETOWN, VILLAGE OF
SEWAGE TREATMENT PLANT
TREATED EFFLUENT DATA

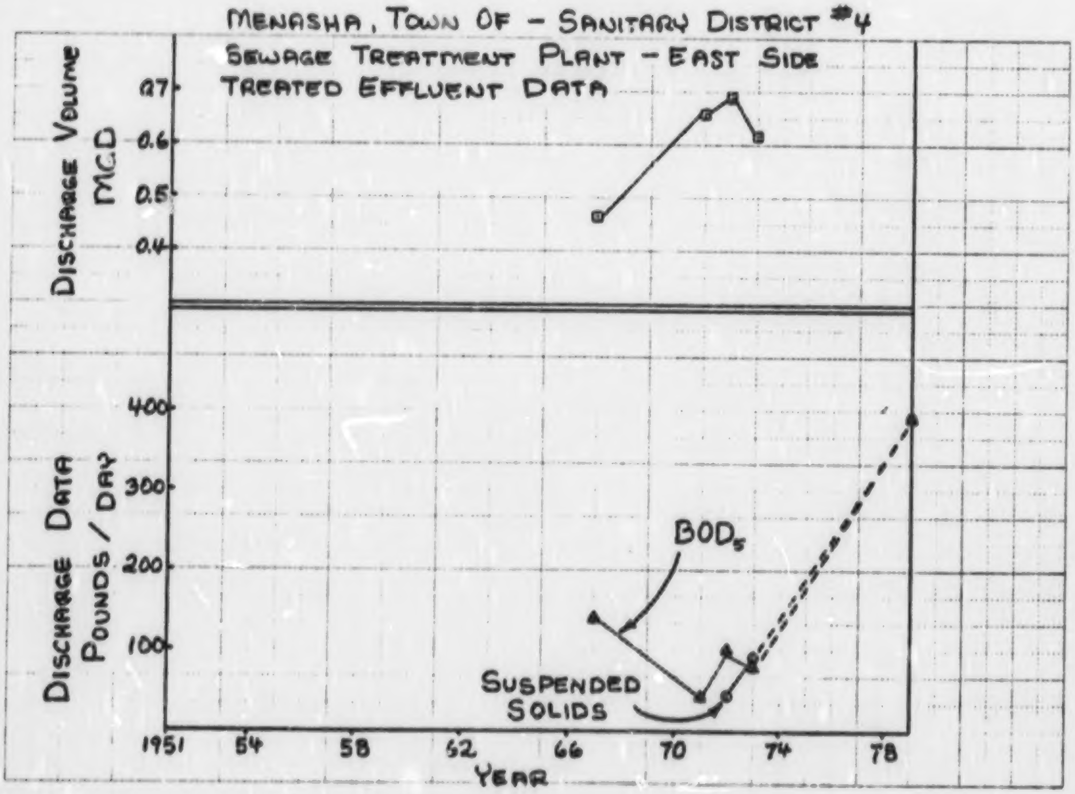


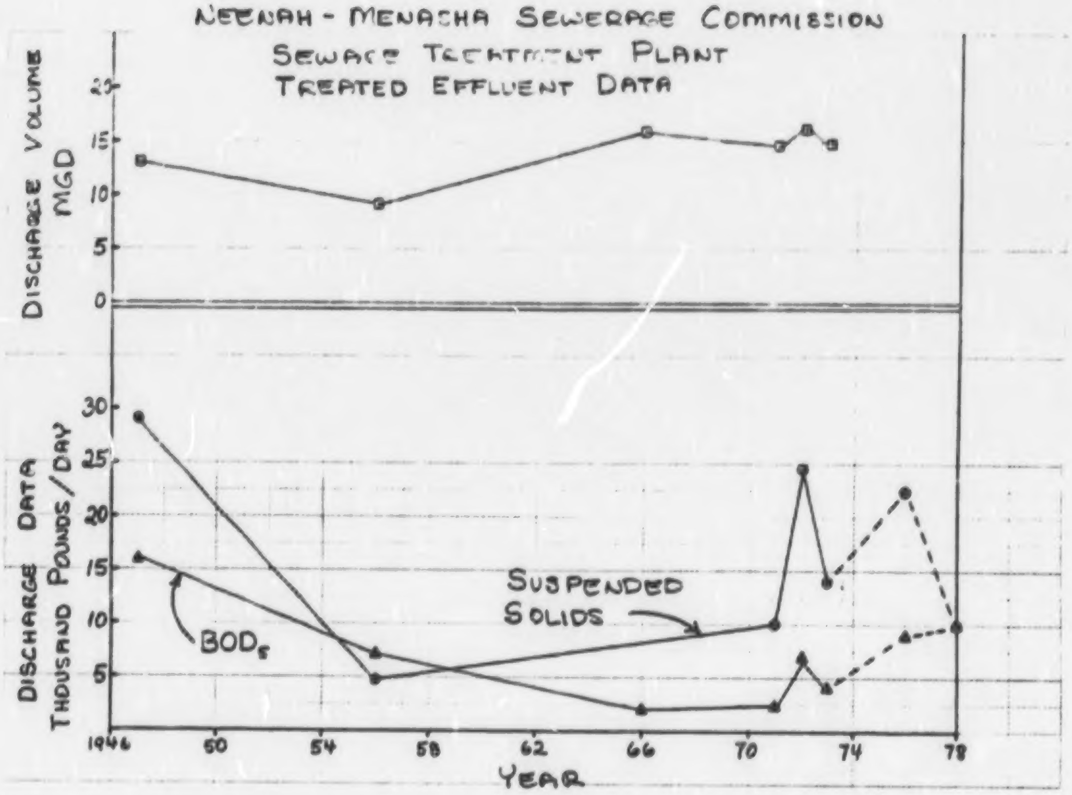
KAUKAUNA, CITY OF
SEWAGE TREATMENT PLANT
TREATED EFFLUENT DATA


LITTLE CHUTE, VILLAGE OF
SEWAGE TREATMENT PLANT
TREATED EFFLUENT DATA

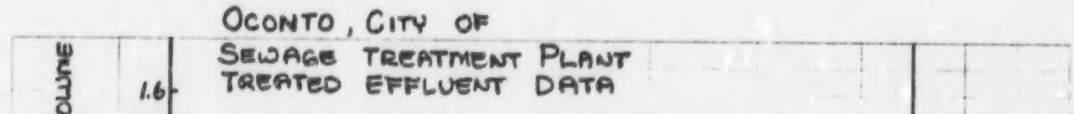

KIMBERLY, VILLAGE OF
SEWAGE TREATMENT PLANT
TREATED EFFLUENT DATA


APPLETON, CITY OF
SEWAGE TREATMENT PLANT
TREATED EFFLUENT DATA

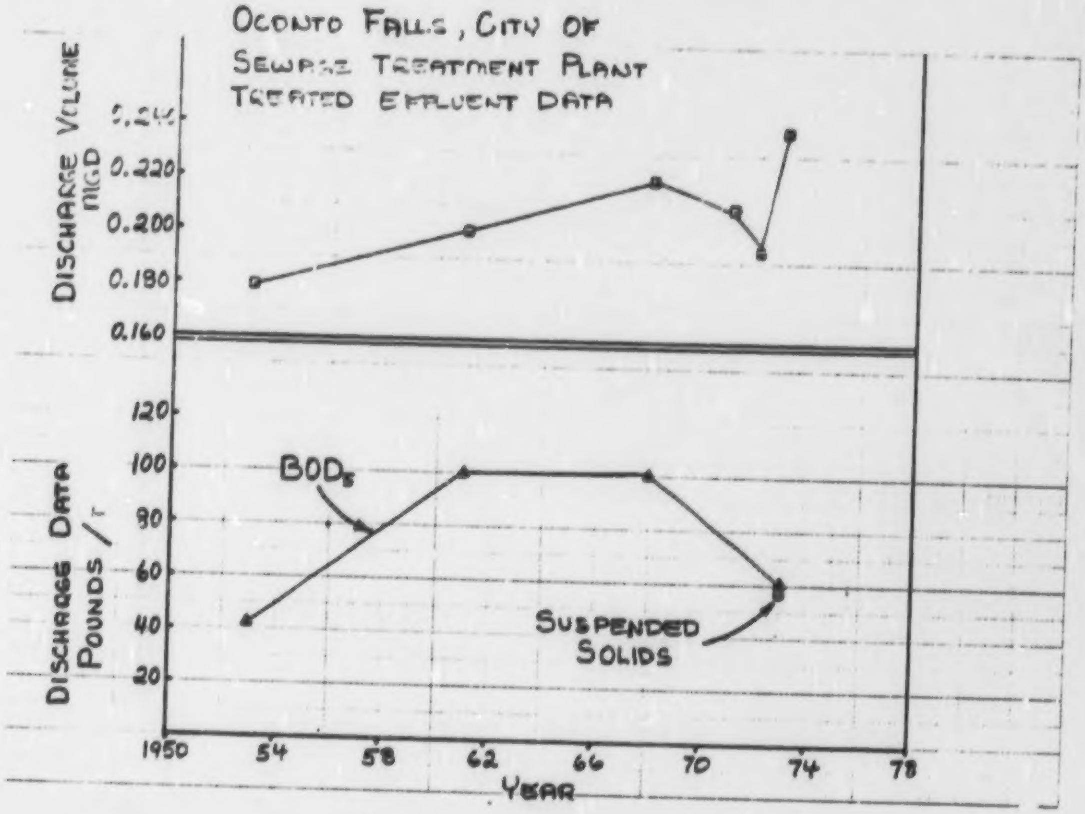

MENASHA, TOWN OF – SANITARY DISTRICT #4
SEWAGE TREATMENT PLANT – EAST SIDE
TREATED EFFLUENT DATA

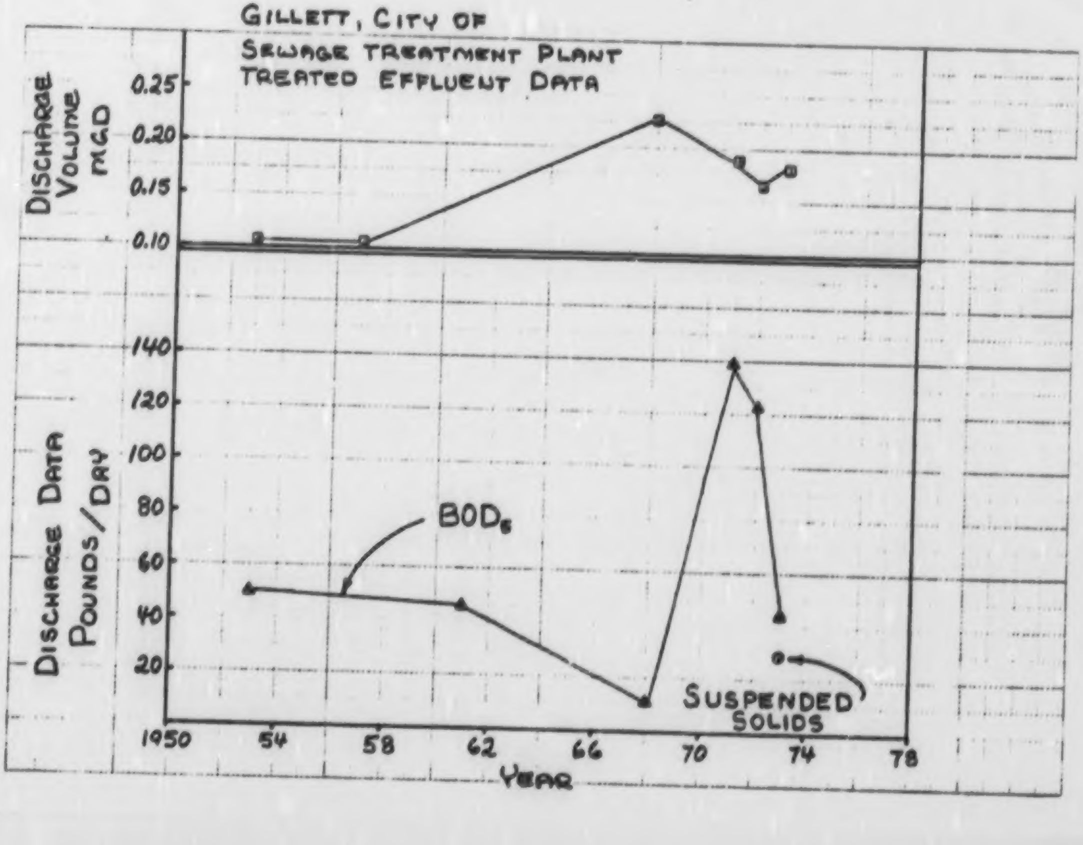


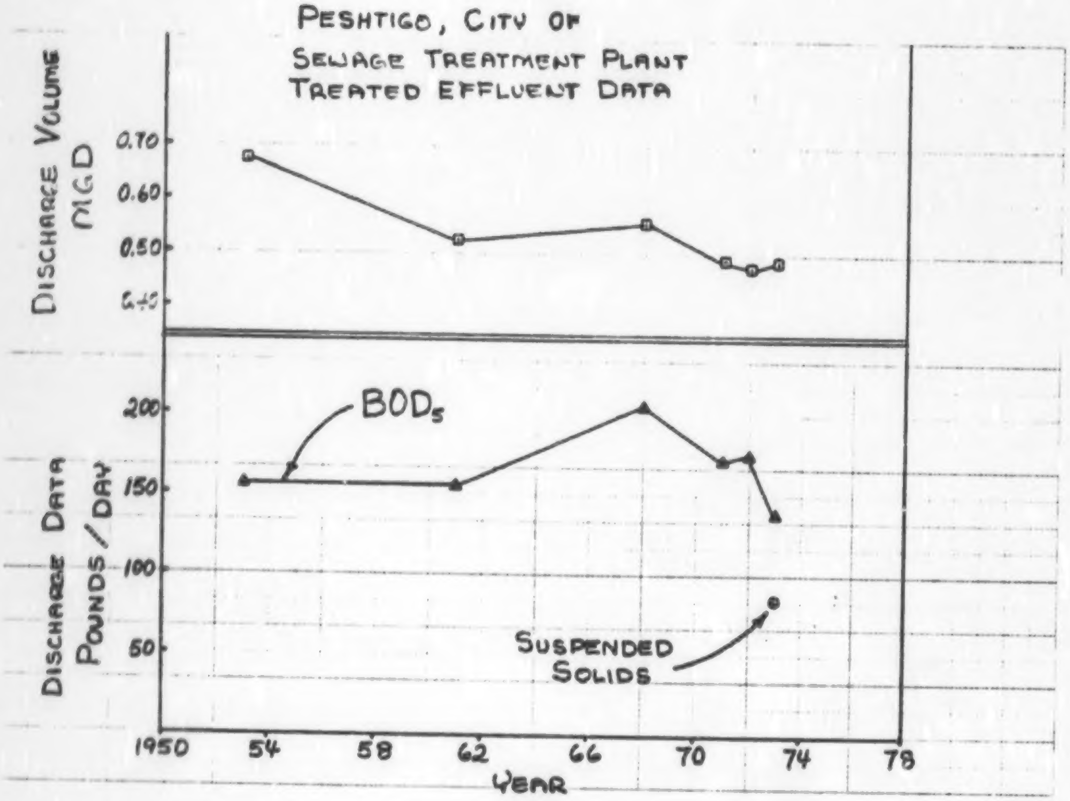
NEENAH - MENASHA SEWERAGE COMMISSION
SEWAGE TREATMENT PLANT
TREATED EFFLUENT DATA

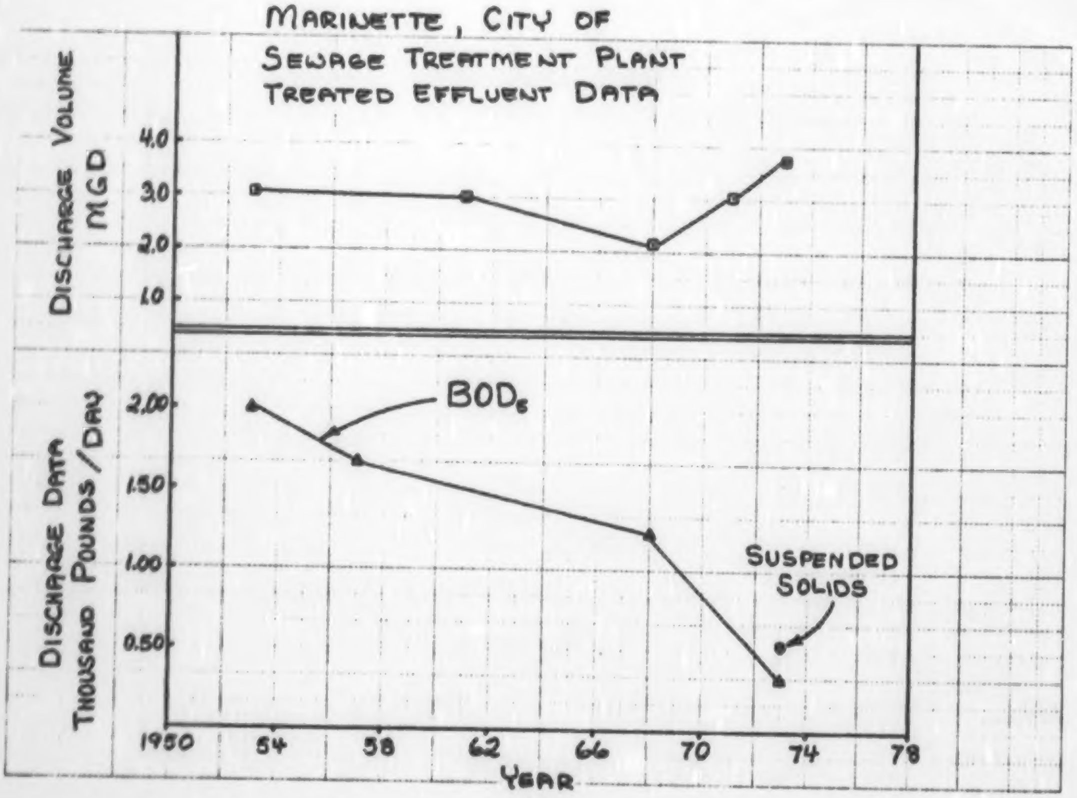


OCONTO, CITY OF
SEWAGE TREATMENT PLANT
TREATED EFFLUENT DATA


Oconto Falls, City of
Sewage Treatment Plant
Treated Effluent Data
Discharge Volume MGD
0.240
0.220
0.200
0.180
0.160
Discharge Data Pounds/D
120
100
80
60
40
20
BOD5
Suspended Solids
1950
54
58
62
66
70
74
78
Year


Gillett, City of
Sewage Treatment Plant
Treated Effluent Data
Discharge Volume MGD
0.25
0.20
0.15
0.10
Discharge Data Pounds/Day
140
120
100
80
60
40
20
BOD5
Suspended Solids
1950
54
58
62
66
70
74
78
Year


PESHTIGO, CITY OF
SEWAGE TREATMENT PLANT
TREATED EFFLUENT DATA
DISCHARGE VOLUME MGD
0.70
0.60
0.50
0.40
BOD5
DISCHARGE DATA POUNDS / DAY
200
150
100
50
SUSPENDED SOLIDS
1950
54
58
62
66
70
74
78
YEAR


MARINETTE, CITY OF
SEWAGE TREATMENT PLANT
TREATED EFFLUENT DATA
DISCHARGE VOLUME MGD
4.0
3.0
2.0
1.0
BOD5
DISCHARGE DATA THOUSAND POUNDS / DAY
2.00
1.50
1.00
0.50
SUSPENDED SOLIDS
1950
54
58
62
66
70
74
78
YEAR

APPENDIX IV.

LOWER FOX, OCONTO, PESHTIGO AND MENOMINEE RIVERS - PRESENT AND PROPOSED WASTE TREATMENT FACILITIES.

MUNICIPAL SEWAGE TREATMENT PLANTS

APPENDIX IV

LOWER FOX RIVER

Green Bay Metropolitan Sewerage District

Present facilities include a trickling filter type of sewage treatment with disinfection. Plant expansion is now underway and will consist of activated sludge plus phosphorus removal with a design capacity of 52 MGD.

De Pere, City

Treatment consists of activated sludge with disinfection and phosphorus removal. Plant design is underway and will include expansion of existing activated sludge system plus tertiary filtration.

Wrightstown, Village

Treatment is by way of trickling filter system with disinfection of effluent. No future plans have been submitted.

Kaukauna, City

Kaukauna plant also provides treatment for Village of Combined Locks. Treatment consists of activated sludge with disinfection and phosphorus removal. Plant design is currently underway for a regional system to be designated as "Heart of the Valley" Sewage Treatment Plant. Treatment will consist of activated sludge process plus phosphorus removal. Approximate completion date, 1977-1978.

Little Chute, Village

Currently has activated sludge process with disinfection and phosphorus removal. Plans are to abandon plant and connect to Heart of the Valley plant.

Kimberly, Village

Facilities include activated sludge treatment with disinfection and phosphorus removal. Plans are to abandon current plant and connect to Heart of the Valley plant.

Appleton, City

Treatment consists of activated sludge with disinfection and phosphorus removal. Plant designs are complete and include modification of the activated sludge system.

Menasha, Town - S.D. #4, East Plant

Two parallel treatment plants, both of which are of the activated sludge process with disinfection and phosphorus removal. No future plans submitted.

Menasha, Town - S.D. #4, West Plant

Contact stabilization process with disinfection of effluent. No future plans submitted.

Neenah-Menasha Sewerage Commission

Present facilities provide for activated sludge treatment plus disinfection and phosphorus removal. Plant designs have been completed and include expansion of activated sludge process to handle 40 MGD.

OCONTO RIVER

Ocon City

. tment consists of trickling filter plus activated sludge with disinfection and phosphorus removal.

Oconto Falls, City

Currently has trickling filter with disinfection of effluent. Joint treatment facility with Scott Paper Company under consideration. Proposal is for aerated lagoon.

Gillett, City

Activated sludge process with disinfection. No future plans have been submitted.

PESHTIGO RIVER

Peshtigo, City

Treatment is by way of trickling filter and disinfection. Aerated lagoon for joint treatment with Badger Paper is now under construction.

MENOMINEE RIVER

Marinette, City

New activated sludge plant was placed in operation during 1973. Treatment provides disinfection and phosphorus removal. Previously, only primary treatment was provided.

APPENDIX V.

LOWER FOX, OCONTO, PESHTIGO AND MENOMINEE RIVERS - COMPREHENSIVE POINT SOURCE AND STREAM SURVEYS, 1966-1968

LOWER FOX RIVER - MAIN STEM
1966-1967

					Est. Daily Discharge	
No.	Source or Stream	Miles	Type of Waste	Treatment	Gallons	Lbs. B.O.D.
1	Gilbert Paper Company	39.8+	Rag pulping & Paper	Save-all & Metro.	890,000	740
2	John Strange Paper Company	39.8	Paper	Save-all & Metro.	1,600,000	1,840
3	George A. Whiting Paper Company	38.7	Paper	Save-all	320,000	380
4	Bergstrom Paper Company	39.8	De-inked Pulp & Paper	Clarification	4,200,000	19,700
5	Kimberly-Clark Neenah Division	40.1	Rag Pulping & Paper	Save-all & Metro.	530,000	300
6	Kimberly-Clark Badger Globe	39.9	Paper	Save-all & Metro.	530,000	140
7	Kimberly-Clark Lakeview	39.2	Paper	Save-all & Metro.	5,250,000	1,460
	Neenah Slough	38.4				
8	Kimberly Clark STP	37.7	Sewage	Secondary	7,000	1.2
9	Neenah-Menasha, Cities of	37.6	Sewage	Secondary	16,000,000	2,080
9A	Kimberly Clark Marketing Center	37.5	Sewage	Secondary	?	?
10	Menasha, Town of Sanitary District #4	36.0	Sewage	Secondary	465,000	140
11	Holiday Inn	35.8	Sewage	Secondary	9,850	1.3
	Mud Creek	34.2				
12	Riverside Paper Corporation	33.3	Paper	Save-all	2,530,000	1,500
13	Consolidated Papers Inc.	32.1	Sulfite Pulp	S.S.L. Evaporation	8,130,000	30,880
14	Foremost Foods	30.8	Dairy	None	1,281,000	299
15	Appleton, City of	30.0	Sewage	Secondary	8,339,000	5,890
16	Kimberly-Clark Kimberly	29.0	Sulfite Pulp & Paper	Save-all & Lagoon	11,490,000	28,600
	Tributary	27.4				
17	Kimberly, Village of	27.0	Sewage	Secondary	359,000	90
18	Combined Paper Mills Inc.	27.0	Chemi-mechanical Pulp & Paper	Save-all & Clarification	3,050,000	5,760
19	Little Chute, Village of	26.8	Sewage	Secondary	403,000	167
	Kankapot Creek	23.7				
20	Kaukauna, City of	23.1	Sewage	Secondary	1,275,000	255
21	Thilmany Pulp & Paper Co.	23.0	Kraft Pulp & Paper	Save-all & Lagoon	26,160,000	33,660
	Plum Creek	17.4				
22	Wrightstown, Village of	16.8	Sewage	Secondary	90,000	40
23	Charmin Paper Products Co.	12.9	Groundwood Pulp	Little Rapids Pulp Mill Closed 10/31/67	30,000	100
24	Hickory Grove Sanitorium	12.0	Sewage	Secondary	14,800	6

					Est. Daily Discharge	
No.	Source or Stream	Miles	Type of Waste	Treatment	Gallons	Lbs. B.O.D.
	Apple Creek	11.2				
25	Nicolet Paper Company	7.0	Paper	Save-all	1,620,000	580
26	U.S. Paper Mills Corp.	6.8	De-inked Pulp & Paper	Save-all & Lagoon	620,000	4,060
27	De Pere, City of	6.2	Sewage	Secondary	1,500,000	1,065
	Ashwaubenon Creek	5.6				
	Dutchman Creek	4.8				
28	Fort Howard Paper Company	3.7	De-inked Pulp & Paper	Save-all & Lagoon	11,400,000	32,720
29	Fort Howard Paper Company STP	3.6	Sewage	Secondary	41,000	15
30	American Can Company, Green Bay	1.4	Sulfite Pulp & Paper	S.S.L. Evaporators & Lagoons	16,300,000	43,180
	East River	1.4				
31	Charmin Paper Products Co.	1.0	Sulfite Pulp & Paper	S.S.L. Evaporators	15,380,000	45,520
32	Green Bay Packaging Inc.	0.8	Neutral sulfite sulfite semi-chemical pulp & Paper	Fluidized bed & Clarification	2,830,000	25,720
	Storm Sewer	0.7				
33	Green Bay Metropolitan Sewage District	0.1+	Sewage	Secondary	13,500,000	16,200
			NEENAH SLOUGH			
33A	Menasha Corporation	2.6	Sewage	Secondary	?	?
34	Neenah Foundry	2.5	Foundry	None	?	?
	Neenah Foundry	0.6	Foundry	None	?	?
35	Galloway Company	0.6	Milk	None	?	?
			MUD CREEK			
36	Fox River Tractor Company	3.7	Sewage	Secondary	?	?
37	Wisconsin Rendering Company	0.6	Cooling Water	None	?	?
	Tributary #1	0.5				
	Tributary #2	0.5				
38	Butte des Morts Utility Dist.	0.4	Sewage	Secondary	255,400	19
			Tributary #1			
39	Elm Tree Bakery	0.3	Bakery	Air Flotation	--	--
			Tributary #2			
40	Terrace Motor Inn	0.5	Sewage	Septic Tank	?	?

No.	Source or Stream	Miles	Type of Waste	Treatment	Est. Daily Discharge Gallons	Est. Daily Discharge Lbs. B.O.D.
		TRIBUTARY				
41	Hietpas Dairy Farms	2.7	Milk	None	1,200	2
42	Coenen Packing Company	2.1	Packing	Septic Tank & Tile Field	?	?
		KANKOPOT CREEK				
43	Brookside Cheese Factory	7.6	Milk	None	5,000	21
		PLUM CREEK				
44	White Cl Dairy	11.6	Milk	Connected to Sanitary District	--	--
45	Holland, Town of, Sanitary District	11.2	Sewage	Secondary	61,000	265
		APPLE CREEK				
		a. Tributary				
46	Pleasant View Cheese Factory	2.6	Milk	None	4,000	9
		ASHWAUBENON CREEK				
47	Fox River Valley Coop Creamery	7.6	Milk	Sand Filter	2,250	1
		DUTCHMAN CREEK				
	a. Tributary #1	3.8				
	b. Tributary #2	0.5				
		a. Tributary #1				
48	Austin-Straubel STP	2.8	Sewage	Secondary	48,500	6
		b. Tributary #2				
49	Paper Converting Machine Co.	0.1	Sewage	Connected to City System	?	?
		EAST RIVER				
	a. Tributary					
50	Rockland River View Cheese Factory	18.1	Milk	Pond	4,400	9
51	Scray's Cheese Company	14.0	Milk	Septic Tank	1,600	13
	b. Bower Creek	5.2				
	c. Baird's Creek	1.7				

No.	Source or Stream	Miles	Type of Waste	Treatment	Est. Daily Discharge Gallons	Lbs. B.O.D.
			a. Tributary			
52	Wrightstown Sanitary District No. 1	1.6	Sewage	Secondary & Pond	16,500	20
			b. Bower Creek			
53	Shirley Farmers Coop Cheese Factory	11.3	Milk	None	?	?
			c. Baird's Creek			
54	Liebmann Packing Company	1.8	Paunch Manure	Lagoon	0	0
			STORM SEWER			
55	C & NW Railroad	0.3	Oil	None	?	--

LOWER FOX RIVER - MAIN STEM
1966-1967

No.	Waste Source	Miles	Sample Source	Date	B.O.D. mg/1	Temp. °C.	pH	D.O. mg/1	MFCC per 100 ml.
1	Gilbert Paper Company	39.8+	Outfall						
2	John Strange Paper Company	39.8	Outfall						
3	George A. Whiting Paper Company	38.7	Outfall						
4	Bergstrom Paper Company	39.8	Outfall						
5	Kimberly-Clark Neenah-Division	40.1	Outfall						
6	Kimberly-Clark Badger Globe	39.9	Outfall						
		39.3	Above Neenah Dam, East Side	7-7	--	--	--	11.9	--
				7-22	10.1	24½	9.2	13.5	900
				7-26	6.4	24½	9.0	8.6	11,000
				9-12	8.8	23	9.0	14.8	< 100
				2-14-67	1.2	3	8.0	11.9	100
				9-7-67	9.5	22	9.3	11.6	400
		39.3	Above Neenah Dam, Middle --Surface	7-7	--	--	--	11.0	--
		39.3	--1½ Meters	7-7	--	--	--	11.2	--
		39.3	Above Neenah Dam, West Side	7-7	--	--	--	10.7	--
				7-22	8.9	24½	9.2	12.8	700
				7-26	4.3	24½	9.0	8.6	3,800
				9-12	7.4	23	9.1	14.7	100
				2-14-67	1.4	3	7.6	9.4	<100
				9-7-67	10	22	9.2	11.6	700
7	Kimberly-Clark Lakeview	39.2	Outfall						
		38.8	Above Menasha Dam, East Side	7-7	--	--	--	11.3	--
				7-22	8.7	24	9.2	11.7	3,000
				7-26	5.7	25	9.1	9.3	500
				9-12	10.2	24	9.4	15.4	200
				2-14-67	0.6	3	8.1	13.1	< 100
				9-7-67	12	27	9.2	12.1	500

No.	Waste Source	Miles	Sample Source	Date	B.O.D. mg/1	Temp. °C.	pH	D.O. mg/1	MFCC per 100 ml.
		38.8	Above Menasha Dam, Middle --Surface	7-7	--	--	--	11.1	--
		38.8	--1½ Meters	7-7	--	--	--	11.1	--
		38.8	Above Menasha Dam, West Side	7-7	--	--	--	11.1	--
				7-22	10.1	24½	9.2	11.6	500
				7-26	5.1	25	9.1	9.2	5,000
				9-12	10.1	24	9.4	15.1	300
				2-14-67	1.8	3	8.0	12.0	< 100
				9-7-67	13	22	9.3	12.5	500
8	Kimberly-Clark Corporation	37.7	STP Outfall	11/1/67	20	--	7.6	--	--
9	Cities of Neenah & Menasha	37.6	STP Outfall	10/30/67	7.4	--	7.6	--	--
9A	Kimberly-Clark Marketing Center	37.5	STP Outfall	--	--	--	--	--	--
		37.4	R.R. Bridge Below, East Side	7-26	8.5	27	9.2	12.7	8,000
				9-12	9.3	23½	9.2	13.7	4,000
				2-14-67	8.0	4	8.0	12.8	3,000
				9-7-67	13	22	9.2	11.4	1,000
		37.4	R.R. Bridge Below, Center	7-26	13	26½	9.2	10.7	46,000
				9-12	19.6	24½	8.8	10.2	50,000
				2-14-67	4.9	4	8.0	12.6	280,000
				4-7-67	8.0	22	9.2	10.8	3,000
		37.4	R.R. Bridge Below, West Side	7-26	11.5	27	9.2	11.6	320,000
				9-12	13.0	24	9.1	12.7	30,000
				2-14-67	2.1	3	7.8	11.7	1,000
				9-7-67	12	23	9.1	10.4	20,000
10	Town of Menasha Sanitary District	36.0	STP Outfall	10-31-67	36	--	7.1	--	--
11	Holiday Inn	35.8	STP Outfall	9-27	34.1	24	7.8	0.6	--
				11-10	19.7	--	--	--	--
				10-31-67	16	--	7.5	--	--
		33.6	Above Appleton, East Side	7-7	--	--	--	7.9	--
				7-22	8.4	24	8.7	7.2	100,000
				7-27	6.8	26	8.8	6.0	110,000
				9-12	6.5	23½	8.2	6.1	30,000
				2-14-67	3.1	2	7.8	11.6	130,000
				9-7-67	12	22	9.0	5.0	29,000

No.	Waste Source	Miles	Sample Source	Date	B.O.D. mg/1	Temp. °C.	pH	D.O. mg/1	MFCC per 100 ml.
		33.6	Above Appleton Center --Surface	7-7	--	--	--	8.1	--
		33.6	--1½ Meters	7-7	--	--	--	6.0	--
		33.6	Above Appleton Center	7-22	9.5	24	8.8	6.7	90,000
				7-27	6.9	26	8.8	5.1	100,000
				9-12	8.4	24	8.6	8.2	130,000
				2-14-67	3.4	2	7.6	11.6	83,000
				9-7-67	16	23	9.0	8.2	400,000
		33.6	Above Appleton West Side	7-7	--	--	--	7.5	--
				7-22	10.1	23½	8.9	7.2	90,000
				7-27	6.8	26	8.8	5.8	90,000
				9-12	7.9	24	8.4	7.8	50,000
				2-14-67	3.2	2	7.6	11.2	< 1,000
				9-7-67	16	23	9.1	9.0	30,000
12	Riverside Paper Corporation	33.3	Outfall						
13	Consolidated Papers Inc.	32.1	Outfall						
	Foremost Foods	30.8	Outfall #1	2-7-67	13.1*	--	--	--	--
		30.8	Outfall #2	2-7-67	15.8*	--	--	--	--
		30.8	Outfall #3	2-7-67	< 6 *	--	--	--	--
		30.8	Outfall #4	2-7-67	43 *	--	--	--	--
		30.8	Outfall #5	2-7-67	430 *	--	--	--	--
15	City of Appleton	30.0	STP Outfall	10-25	53.2*	17	7.4	1.2	--
16	Kimberly-Clark Kimberly	29.0	Outfall						
		28.2	Above Kimberly East Side	7-7	--	--	--	4.8	--
				7-22	12.7	23½	7.9	2.0	480,000
				7-27	10.0	26½	8.0	2.3	1,000,000
				9-12	8.9	22½	7.4	1.6	600,000
				2-14-67	6.0	2	7.6	12.7	200,000
				9-7-67	13	22	8.0	1.8	2,800,000
		28.2	Above Kimberly Center -- Surface	7-7	--	--	--	4.3	--
		28.2	--1½ Meters	7-7	--	--	--	3.9	--

No.	Waste Source	Miles	Sample Source	Date	B.O.D. mg/1	Temp. °C.	pH	D.O. mg/1	MFCC per 100 ml.
		28.2	Above Kimberly Center	7-22	6.6	24	8.4	3.3	150,000
				7-27	9.8	27	8.0	2.2	280,000
				9-12	9.6	23	7.4	1.9	500,000
				2-14-67	4.0	2	7.8	12.3	54,000
				9-7-67	13	23	7.9	1.6	290,000
		28.2	Above Kimberly West Side	7-7	--	--	--	4.2	--
				7-22	9.5	23½	8.2	2.9	130,000
				7-27	9.2	26½	8.0	2.1	90,000
				9-12	11.8	23	7.5	2.2	240,000
				2-14-67	5.8	2	7.8	12.4	20,000
				9-7-67	13	22	8.2	1.7	300,000
17	Village of Kimberly	27.0	STP Outfall	8-24-67	32.4*	20	7.6	1.5	--
				3-30	22.4*	9	7.4	5.5	--
18	Combined Paper Mills, Inc.	27.0	Outfall						
19	Village of Little Chute	26.8	STP Outfall	5-9-67	99 *	11	7.6	0.1	--
		24.5	Above Kaukauna East Side	7-7	--	--	--	3.2	--
				7-21	8.6	25	7.4	1.5	> 300,000
				7-28	9.8	27	7.4	0.1	--
				9-12	14.3	23	7.2	0.1	1,100,000
				2-14-67	12.0	2	7.8	11.7	300,000
				9-7-67	17	22	7.5	0.0	1,300,000
		24.5	Above Kaukauna --Surface Center	7-7	--	--	--	3.7	--
		24.5	2½ Meters	7-7	--	--	--	3.4	--
		24.5	Above Kaukauna Center	7-21	8.1	25	7.5	2.0	>400,000
				7-28	7.2	27	7.4	0.4	--
				9-12	10.3	22½	7.3	0.5	1,000,000
				2-14-67	7.8	2	7.8	12.3	61,000
				9-7-67	13	22	7.5	0.2	1,100,000
		24.5	Above Kaukauna West Side	7-7	--	--	--	5.1	--
				7-21	7.1	25	7.4	2.7	> 150,000
				7-28	7.7	27	7.4	0.9	--
				9-12	8.6	23	7.3	1.1	1,600,000
				2-14-67	4.1	2	7.8	13.2	34,000
				9-7-67	8.0	22	7.5	0.4	700,000
20	City of Kaukauna	23.1	STP Outfall	10-9	77.1*	--	7.4	--	--
21	Thilmany Pulp & Paper Company	23.0	Outfall						

No.	Waste Source	Miles	Sample Source	Date	B.O.D. mg/l	Temp. °C.	pH	D.O. mg/l	MFCC per 100 ml.
		19.7	Below Kaukauna East Side	7-7	--	--	--	0.6	--
				7-21	7.1	24	7.4	0.0	>150,000
				7-28	7.7	28	7.3	1.1	--
				9-12	12.4	23	7.2	0.0	2,600,000
				2-14-67	7.2	1	7.9	11.9	50,000
				9-7-67	9.5	22	7.4	0.2	160,000
		19.7	Below Kaukauna --Surface Center	7-7	--	--	--	0.6	--
		19.7	--2½ Meters	7-7	--	--	--	0.5	--
		19.7	Below Kaukauna Center	7-21	8.7	24	7.4	0.0	> 300,000
				7-28	8.9	27	7.4	0.2	--
				9-12	11.4	23	7.2	0.0	2,500,000
				2-14-67	7.8	1	7.8	12.2	--
				9-7-67	8.9	22	7.4	0.3	100,000
		19.7	Below Kaukauna West Side	7-7	--	--	--	0.9	--
				7-21	8.0	24	7.4	0.0	>250,000
				7-28	8.7	27	7.3	0.2	--
				9-12	11.7	23	7.2	0.0	2,200,000
				2-14-67	8.3	1	7.9	12.0	260,000
				9-7-67	9.8	22	7.5	0.3	400,000
		18.7	Above Wrightstown, East Side	7-20	7.4	25	7.4	1.4	200,000
				7-28	7.5	27	7.3	0.4	--
		18.7	Above Wrightstown, Center	7-20	8.0	25	7.4	1.3	140,000
				7-28	8.0	27½	7.3	0.4	--
		18.7	Above Wrightstown, West Side	7-20	7.5	25	7.4	1.7	100,000
				7-28	8.7	27½	7.4	1.1	--
22	Village of Wrightstown	16.8	STP Outfall	6-15	38.0*	15	7.3	2.5	--
		14.1	Below Wrightstown East Side	7-7	--	--	--	1.2	--
				7-20	3.5	25	7.6	2.7	11,000
				7-28	6.6	28	7.4	2.0	--
				9-12	9.8	22½	7.1	0.2	1,200,000
				2-15-67	8.1	1	7.6	11.0	100,000
				9-7-67	6.2	21	7.5	0.6	21,000
		14.1	Below Wrightstown, Center --Surface	7-7	--	--	--	1.3	--
		14.1	--2 Meters	7-7	--	--	--	1.1	--

No.	Waste Source	Miles	Sample Source	Date	B.O.D. mg/1	Temp. °C.	pH	D.O. mg/1	MFCC per 100 ml.
		14.1	Below Wrights-	7-20	8.9	25	7.6	2.6	11,000
			town Center	7-28	7.4	27½	7.4	1.5	--
				9-12	9.4	22½	7.2	0.2	460,000
				2-15-67	10.0	1	7.8	11.7	180,000
				9-7-67	6.7	21	7.5	0.3	11,000
		14.1	Below Wrights-	7-7	--	--	--	1.1	--
			town, West	7-20	6.0	25	7.6	2.9	9,000
			Side	7-28	6.9	28	7.4	1.5	--
				9-12	9.8	22½	7.2	0.2	> 2,500,000
				2-15-67	8.3	1	7.8	11.8	160,000
				9-7-67	5.2	21	7.5	0.4	17,000
23	Charmin Paper Products Co.	12.9	Outfall						
		12.4	Below Little	7-20	5.7	24	7.8	3.2	8,000
			Rapids East	7-29	8.3	26	7.2	0.6	420,000
			Side	9-8	6.3	22½	8.2	8.8	33,000
		12.4	Below Little	7-20	5.2	24	7.8	2.5	8,000
			Rapids Center	7-29	7.6	26	7.1	0.3	410,000
				9-8	5.5	22	7.6	5.5	44,000
		12.4	Below Little	7-20	6.1	24	7.8	3.6	12,000
			Rapids West	7-29	8.1	26½	7.2	0.2	370,000
			Side	9-8	5.7	22	7.6	5.0	41,000
24	Hickory Grove Sanitary	12.0	STP Outfall	5-11	44.0*	15	7.1	4.0	--
		7.5	Above DePere	7-7	--	--	--	7.4	--
			East Side	7-20	7.8	23	7.8	5.4	22,000
				7-29	7.2	26½	7.4	4.2	10,000
				9-8	7.4	22½	8.4	10.4	15,000
				2-15-67	4.8	½	7.6	10.7	50,000
				9-6-67	8.3	25	8.4	9.0	1,800
		7.5	Above DePere --Surface Center	7-7	--	--	--	7.3	--
		7.5	--3 Meters	7-7	--	--	--	6.4	--
		7.5	Above DePere	7-20	6.4	23	7.8	4.6	20,000
			Center	7-29	6.1	26½	7.2	2.1	20,000
				9-8	7.2	21½	8.2	9.4	18,000
				2-15-67	5.7	½	7.6	11.4	57,000
				9-6-67	11	22	8.1	7.4	1,600
		7.5	Above DePere	7-7	--	--	--	7.4	--
			West Side	7-20	7.5	23	7.8	4.9	13,000
				7-29	5.7	26½	7.2	1.7	20,000
				9-8	7.3	22	7.8	8.0	14,000
				2-15-67	6.9	½	7.6	11.0	69,000
				9-6-67	8.6	22	7.7	4.0	700

No.	Waste Source	Miles	Sample Source	Date	B.O.D. mg/1	Temp. °C.	pH	D.O. mg/1	MFCC per 100 ml.
		7.2	Dam Headrace	2-3	2.8	½	7.4	10.2	73,000
				2-24	4.4	0	7.5	12.8	35,000
				12-12	10.1	1	7.4	--	71,000
				2-1-67	5.4	½	7.4	10.6	56,000
				2-28-67	5.4	1	7.5	10.7	32,000
25	Nicolet Paper Co.	7.0	Outfall						
26	U.S. Paper Mills Corporation	6.8	Outfall						
27	DePere, y of	6.2	STP Outfall	9-21	111.0*	19	7.0	1.0	--
		6.1	Below DePere East Side	7-7	--	--	--	5.7	--
				7-19	6.3	25	7.6	4.7	23,000
				7-29	5.8	26	7.5	6.1	15,000
				9-8	8.9	22½	7.8	9.5	28,000
				2-16-67	7.2	0	7.6	12.0	52,000
				9-6-67	9.2	23	8.1	8.1	13,000
		6.1	Below DePere --Surface Center	7-7	--	--	--	5.5	--
		6.1	--4 Meters	7-7	--	--	--	4.2	--
		6.1	Below DePere Center	7-19	6.7	25	7.5	3.6	16,000
				7-29	8.3	26	7.5	5.8	9,000
				9-8	8.6	22½	7.8	10.2	26,000
				2-16-67	8.4	0	7.5	10.8	29,000
				9-6-67	10	24	8.1	8.4	5,000
		6.1	Below DePere West Side	7-7	--	--	--	5.4	--
				7-19	7.4	25	7.6	5.4	130,000
				7-29	10.3	26	7.4	6.7	100,000
				9-8	8.4	27	7.6	9.0	2,600,000
				2-16-67	8.4	0	7.4	10.1	170,000
				9-6-67	7.1	22	7.5	5.8	3,100,000
28	Fort Howard Paper Company	3.7	Outfall						
29	Fort Howard Paper Company	3.6	STP Outfall	5-18	39.0*	27	7.2	--	--
		2.3	Mason Street	3-29	4.1	3½	7.7	13.1	16,000
				4-28	4.6	9	7.4	7.7	9,000
				5-31	2.4	17½	7.4	4.3	3,500
				6-29	3.4	21½	7.2	1.7	12,000
				7-29	7.1	27	7.3	2.2	25,000
				8-31	5.2	23	7.2	0.1	130,000
				9-28	6.9	15	7.3	3.5	16,000

No.	Waste Source	Miles	Sample Source	Date	B.O.D. mg/l	Temp. °C.	pH	D.O. mg/l	MFCC per 100 ml.
				11-2	6.8	6	7.2	4.5	21,000
				11-30	7.8	1½	7.4	10.6	71,000
				4-13-67	7.4	5	7.8	10.7	16,000
				6-1-67	2.5	18½	7.4	4.6	18,000
				6-29-67	1.8	21	7.6	5.2	28,000
				7-26-67	6.3	31	7.3	7.2	17,000
				9-13-67	0.6	21	7.8	7.0	12,000
30	American Can Co. Green Bay	1.4	Outfall						
31	Charmin Paper Paper Products Co.	1.0	Outfall						
32	Green Bay Packaging Inc.	0.8	Outfall						
33	Green Bay M.S.D.	0.1+	STP Outfall	10-11	143.0*	21	7.5	0.0	--
		0.1	Mouth--East Side	7-7	--	--	--	0.0	--
				7-19	10.0	26	7.2	0.0	40,000
				7-29	>17.1	29	7.0	0.0	610,000
				9-8	13.4	26	7.2	0.9	60,000
				2-16-67	15.5	0	7.5	10.6	33,000
				9-6-67	18	23	7.4	3.4	60,000
		0.1	Mouth - Center --Surface	7-7	--	--	--	0.7	--
		0.1	--3 Meters	7-7	--	--	--	0.3	--
		0.1	--5 Meters	7-7	--	--	--	0.1	--
		0.1	Mouth - Center	7-19	10.3	27	7.2	0.0	90,000
				7-29	>19.4	29	7.0	0.0	510,000
				9-8	15	26	7.2	0.9	40,000
				2-16-67	15.2	0	7.5	10.5	25,000
				9-6-67	17	23	7.2	3.5	120,000
		0.1	Mouth--West Side	7-7	--	--	--	0.7	--
				7-19	10.8	26½	7.2	0.0	60,000
				7-29	>17.9	29	7.0	0.0	510,000
				9-8	15	26	7.2	0.7	100,000
				2-16-67	17.2	0	7.4	10.5	67,000
				9-6-67	9.5	24	7.3	2.5	70,000
		0.0	Green Bay						
			NEENAH SLOUGH						
		3.0	U.S. 41 Above	11-19-64	2.7	3	7.4	8.0	2,200
				5-19-65	2.0	18	7.4	4.3	--
				9-27	2.1	12	7.2	4.5	1,500

No.	Waste Source	Miles	Sample Source	Date	B.O.D. mg/l	Temp. °C.	pH	D.O. mg/l	MFCC per 100 ml.
33A	Menasha Corp.	2.6	STP Outfall	--	--	--	--	--	--
34	Neenah Foundry #2	2.5	Marathon	11-19-64	--	--	--	--	(SUSP SLDS) (744)
			St. Storm	5-18-65	1.1*	--	6.9*	--	(508*)
			Sewer Out-	9-27	13.1	22	--	--	(1290)
			fall	11-10	12.3	--	--	--	(796)
		1.5	Cecil St.	11-19-64	4.5	3	7.6	7.7	300
			Below	5-19-64	3.6	19	7.6	8.0	--
				9-27	2.6	14	7.2	5.5	12,000
34	Neenah Foundry #1	0.6+	Monroe St.	11-18-64	15.6*	--	--	--	(SUSP SLDS) (210)
			Storm	5-18-65	3.4*	--	6.7*	--	(166)
			Sewer Out-	9-27	1.4	38	--	--	(46)
			fall	11-10	3.1	--	--	--	(428)
35	Galloway Co.	0.6	Monroe St.	11-18-64	15.6*	--	--	--	--
			Storm	5-18-64	5.1*	--	7.6	--	--
			Sewer Out-	9-27	>222.	27	8.7	--	--
			fall	11-10	7.7	--	--	--	--
		0.1	Main St.	11-19-64	<1	7	7.6	4.6	61,000
			Below	5-19-65	16.3	19	7.8	6.0	--
				9-27	4.0	18	7.2	2.9	420,000
		0.0	Fox River						

MUD CREEK

No.	Waste Source	Miles	Sample Source	Date	B.O.D. mg/l	Temp. °C.	pH	D.O. mg/l	MFCC per 100 ml.
36	Fox R. Tractor Company	3.7	STP Outfall	11-10	12.6	--	--	--	--
				11-1-67	73	--	7.4	--	--
		2.9	US 41	9-28	30.1	13	7.8	0.2	500,000
				11-1-67	3.9	7	7.6	8.1	--
		2.4	Spencer Ave.	9-28	130	15½	7.0	0.0	12,000,000
				11-1-67	5.8	8	7.8	9.6	--
		1.1	Prospect Ave.	9-28	7.4	12	7.6	0.7	140,000
				11-1-67	4.3	8	7.6	8.9	--
37	Wis. Rendering Company	0.6	Outfall	9-27	10.5	13	7.5	--	--
				11-10	24.3	--	--	--	--
38	Butte des Morts U.D.	0.4	STP Outfall	5-17-67	8.9*	16	7.4	1.7	--
		0.0	Fox River						

No.	Waste Source	Miles	Sample Source	Date	B.O.D. mg/1	Temp. °C.	pH	D.O. mg/1	MFCC per 100 ml.
MUD CREEK TRIBUTARY #1									
39	Elm Tree Bakery	0.3	Outfall	9-28	226	20	7.3	--	--
		0.3-	College Ave.	11-1-67	25	12	8.4	8.1	--
MUD CREEK TRIBUTARY #2									
40	Terrace Motor Inn	0.5	Outfall	9-28	16.9	15	7.4	--	15,000
				11-10	--	--	--	--	700,000
				11-6-67	226	--	--	--	--
				11-1-67	7.4	--	7.5	--	--
LOWER FOX RIVER TRIBUTARY									
		2.9	CTH "E" Above	12-15	NO FLOW				
41	Hietpas Dairy Farm	2.7	Outfall	12-15	225	--	8.2	--	--
		1.7	Town Road	12-15	NO FLOW				
		2.2	CTH "OO" Above	12-15	NO FLOW				
42	Coenen Packing Company	2.1	Outfall	12-15	1340	--	6.9	--	--
		1.6	CTH "OO" Below	12-15	NO FLOW				
		0.0	Lower Fox River						
KANKOPOT CREEK									
		7.6+	US 10 Above	11-7	NO FLOW				
				11-30	NO FLOW				
43	Brookside Cheese Factory	7.6	Outfall	11-7	156	19	4.6	--	--
		7.6		11-30	1580	22	9.6	--	--
		7.3	Town Road Below	11-7	NO FLOW				
				11-30	NO FLOW				
		0.0	Fox River						
PLUM CREEK									
		11.8	CTH "Q" Above	9-1	NO FLOW				
				10-20	NO FLOW				

No.	Waste Source	Miles	Sample Source	Date	B.O.D. mg/1	Temp. °C.	pH	D.O. mg/1	MFCC per 100 ml.
44	White Clover Dairy	11.6+	Outfall	4-20-67	4.0	28	7.8	--	--
		11.6		4-20-67	>122	52	>10.2	--	--
		11.5	CTH "O"	9-1	1.5	22	7.3	5.4	80,000
				10-20	1.4	20	7.4	4.9	170,000
45	Town of Holland Sanitary District	11.2	STP Outfall	11-2-65	731	23	7.5	--	-- (SUPS SLDS)
				9-1	967	29	7.3	--	(1536)
				10-18	521 *	23	7.6	0.0	--
				3-30-67	980	--	--	--	--
				4-20-67	1260	19	6.7	--	(1560)
				7-6-67	746	28	6.7	--	--
		10.9	Below	9-1	580	26	7.6	0.0	9,600,000
				10-20	147	14	7.8	1.3	64,000,000
		7.9	CTH "Z" Below	9-1	33.8	23	8.4	10.2	80,000
				10-20	113	12½	8.2	0.0	280,000
		6.0	Town Road	9-1	8.3	23	8.4	5.8	14,000
				10-20	7.4	9	8.1	3.1	6,000
		0.0	Fox River						
			APPLE CREEK TRIBUTARY						
		6.0+	Above	12-15	NO FLOW				
46	Pleasant View Cheese Factory	6.0	Outfall	12-15	> 831	--	6.8	--	--
		5.3	Buchanan Road Below	12-15	NO FLOW				
		0.0	Fox River						
			ASHWAUBENON CREEK						
47	Fox River Valley Coop. Creamery	7.6	Outfall	11-4-65	50.6	10	7.2	--	--
				12-12	1910	--	5.1	--	--
		0.0	Fox River						
			DUTCHMAN CREEK						
			a. Tributary #1						
		2.9	Above	9-13	NO FLOW				
				11-15	NO FLOW				
48	Austin-Straubel STP	2.8	STP Outfall	9-13	16. *	--	7.3	2.1	--
				11-15	96.1	--	7.4	--	--

No.	Waste Source	Miles	Sample Source	Date	B.O.D. mg/l	Temp. °C.	pH	D.O. mg/l	MFCC per 100 ml.
		2.6	CTH "GH"	9-13	5.3	21½	7.9	2.9	50,000
			Below	11-15	12.9	8	7.9	5.6	40,000
		1.5	Town Road	9-13	4.1	22½	8.8	12.7	28,000
			Below	11-15	1.2	4	8.0	13.1	4,500
		0.1	CTH "GG"	9-13	NO FLOW				
			Below						
		0.0	Dutchman Creek						
			b. Tributary #2						
		0.1+	Above	11-15	NO FLOW				
				12-12	NO FLOW				
49	Paper Converting Machine Company	0.1	Outfall	11-15	36.3	--	9.1	--	--
				12-12	147	--	--	--	1,300,000
		0.0	Dutchman Creek						
			EAST RIVER						
		18.1+	Above	11-7	8.0	5	8.2	11.9	1,600
				11-30	5.7	3	8.2	13.1	6,000
50	Rockland River View Cheese Factory	18.1	Pond Outfall	11-7	39.0	7	7.6	4.9	--
				11-30	280	3	7.0	0.4	--
		17.9	STH "57"	11-7	8.4	5	8.1	9.4	16,000
			Below	11-30	5.0	3	8.1	8.8	3,800
		14.0+	Above	11-7	0.9	6	8.2	10.3	1,700
				11-30	3.6	2	8.2	12.3	2,200
51	Scray's Cheese Co.	14.0	Outfall	11-7	1030	16	7.4	--	--
				11-30	1030	16	7.2	--	--
		13.9	Town Road	11-7	3.0	4	7.7	9.2	2,000
			Below	11-30	5.0	2	8.2	11.6	32,000
		4.3	Allouez Ave.	8-3	1.5	22	7.6	4.8	--
				8-24	3.9	21	8.2	8.7	6,000
				11-8	3.8	6½	8.4	12.8	2,700
		2.1	Mason St.	8-3	4.9	22½	7.4	2.8	150,000
				8-24	3.0	20	7.4	5.7	21,000
				11-8	4.0	5½	7.8	10.0	27,000
		1.3	Baird St.	8-3	4.3	22½	7.3	0.7	530,000
				8-24	3.0	21	7.3	2.5	23,000
				11-8	4.7	5½	7.4	6.6	12,000

No.	Waste Source	Miles	Sample Source	Date	B.O.D. mg/1	Temp. °C.	pH	D.O. mg/1	MFCC per 100 ml.
		1.0	Main Street	8-3	6.4	23	7.3	0.5	30,000
				8-24	4.5	21	7.2	1.5	11,000
				11-8	9.1	5	7.2	5.3	14,000
		0.7	Webster Ave.	8-3	9.5	23	7.3	0.4	8,500,000
				8-24	3.8	21½	7.2	1.6	60,000
				11-8	7.8	5.5	7.2	4.4	20,000
		0.3	Monroe St.	8-3	7.7	24	7.3	0.4	4,200,000
				8-24	5.6	22	7.2	1.6	100,000
				9-8	7.1	23	7.2	1.0	40,000
				11-8	10.5	6	7.0	4.5	13,000
		0.0	Fox River						
			EAST RIVER TRIBUTARY						
		1.7	STH "96" Above	4-6	(NO FLOW)				
				9-28	(NO FLOW)				
				10-20	(NO FLOW)				
52	Village of Greenleaf, Wrightstown Sanitary District #1	1.6	STP Pond Outfall	4-6	27.8*	4	8.8	10.0	--
				9-28	8.4	13	9.2	--	--
				10-20	10	10½	9.2	18.2	10,000
		0.8	Town Road Below	4-6	(NO FLOW)				
				9-28	(NO FLOW)				
				10-20	(NO FLOW)				
		0.0	East River						
			BOWER CREEK						
		11.4	Town Road Above	5-16-67	(NO FLOW)				
				7-6-67	3.5	21	7.5	5.8	400,000
53	Shirley Farmers Coop. Cheese Factory	11.3	Outfall	5-16-67	1560	--	5.1	--	--
				2-6-67	885	21	6.2	--	40,000,000
		11.1	Below	5-16-67	84.5	19	7.0	0.0	--
				7-6-67	94.9	19	7.3	1.4	3,200,000
		10.2	CTH "X" Below	5-16-67	2.9	20	8.8	13.6	--
				7-6-67	3.5	25	7.7	5.4	7,000
		0.0	East River						
			BAIRD"S CREEK						
		1.9	Above	4-20	0.9	10	8.2	10.5	600

No.	Waste Source	Miles	Sample Source	Date	B.O.D. mg/1	Temp. °C.	pH	D.O. mg/1	MFCC per 100 ml.
54	Liebmann Packing Company	1.8	(NO DISCHARGE)						
		1.7	Below	4-20	0.6	10	8.0	10.2	< 100
		1.3	Danz Ave.	8-3	6.8	29	11.2	6.2	<100
				8-24	1.8	21	8.8	9.6	12,000
				11-8	1.4	8	8.4	15.4	3,300
		0.7	Henry St.	8-3	1.8	20	8.6	5.6	270,000
				8-24	1.7	18	8.2	7.9	10,000
				11-8	7.4	8	7.6	5.2	230,000
		0.3	Main St.	8-3	97.4	21	7.3	0.0	7,000
				8-24	5.1	19	8.4	1.7	210,000
				11-8	> 17.9	9	8.4	3.9	210,000
		0.0	East River						
			PRAIRIE AVENUE STORM SEWER						
55	C & NW Railroad	0.3+	Outfall						
		0.3	Drainage Ditch	10-20	2.1	12	7.2	6.8	--
		0.3-	Outfall						
		0.1	Storm Sewer	10-20	108	--	--	--	(OIL) (266)
				11-15	100	--	--	--	--
		0.0	Fox River						

* Composite Sample

( ) Additional Information

OCONTO RIVER
DRAINAGE BASIN SURVEY
1968

No.	Source or Stream	Miles	Type of Waste	Treatment	Est. Discharge to Stream per Day Gallons	Lbs. 5-Day B.O.D.
	OCONTO RIVER - MAIN STEM					
	Fork-N. & Branches	54.5				
1	Suring, Vil. of	53.5	Sewage	Secondary	31,140	4
	Christie Brook	25.8				
2	Scott Paper Co. Oconto Falls, Wis.	19.6	Pulp & Paper	Lagoon Save-alls, Evaporation, Hauling	10,720,000	29,440
3	Oconto Falls, City of	19.5	Sewage	Secondary	220,000	105
	Little River	10.0				
4	Oconto, City of	1.3	Sewage	Secondary	1,449,000	845
	a - Bond Pickle Co.					
	b - Wis. Dried Egg Co.					
	Green Bay	0.0				
	A. North Branch Oconto River					
5	Wabeno, Uninc, Vil. of	49.8	Sewage	Private Systems	--	--
	Oconto River	0.0				
	B. Christie Brook					
6	Gillett, City of	2.3	Sewage	Secondary	227,300	11
	a. Gillett Cold Storage		Slaughtering			
7	Country Gardens, Inc. Gillett, Wis.	2.1	Canning	Spray Irrigation	9,000,000	--
	Oconto River	0.0				

o.	Source or Stream	Miles	Type of Waste	Treatment	Est. Discharge to Stream per Day Gallons	 Lbs. 5-Day B.O.D.
	C. Little River					
	Kelly Brook	14.4				
	Jones Creek	8.1				
	Oconto River	0.0				
	1. Jones Creek					
	Lena, Vil. of	6.5	Sewage	Secondary	?	?
	Frigo Bros. Ch. Corp. Lena, Wis.	6.1	Milk	Cooling Water	--	--

OCONTO RIVER DRAINAGE BASIN
1968

No.	Waste Source	Miles	Sample Source	Date	B.O.D. mg/l	Temp. °C.	pH	D.O. mg/l	MFCC per 100 ml.
			OCONTO RIVER - MAIN STEM						
		53.6	STH "32" bridge above	5-22	2.5	13	7.3	9.1	4,300
				9-10	1.5	15	7.4	8.4	4,300
1	Suring, Vil of	53.4	STP Outfall	5-22	17.0*	14	7.1	0.2	--
				9-10	71.0	17½	7.5	--	--
		52.0	Off Town Rd. below	5-22	2.0	13½	7.3	9.0	2,000
				9-10	1.5	15½	7.1	8.2	6,400
		22.9	Town Road Above Oconto Falls	2-26	1.4	1	7.4	11.4	5,100
				8-27	<1.0	17	7.8	7.9	1,700
				11-4	2.3	7	7.3	11.4	1,100
		19.6	CTH C	8-6 PM	2.5	--	--	8.1	average of 3
				8-7 AM	–	--	--	6.8	average of 3
				11-4	1.8	7	7.4	11.4	800
2	Scott Paper Co.	19.6	Outfall						
		19.5+	100' above STP	3-11	101.	--	6.5	--	--
				11-4	66.	8	7.4	--	61,000
3	Oconto Falls, City of	19.5	STP Outfall	2-26	87.	6	7.8	5.7	--
				3-19	57. *	8½	8.0	6.4	--
				8-27	62.	18	7.7	4.5	--
				10-3	73.	--	7.9	--	--
				11-4	69.	8½	7.8	2.5	--
2	Scott Paper Co.	19.5	Clarifier Outfall	2-26	85.	6	7.3	11.2	--
				8-27	10.	22½	6.9	7.2	--
				10-3	55.				
				11-4	78.	11½	7.2	--	510,000
		19.4	100 yds. below						
			1) Left side	8-27	2.5	21½	8.0	7.7	--
			2) Right side	8-27	6.1	22½	7.5	4.6	--
		18.4	Mill View Farm	8-6	5.1	26½	7.6	4.1	average of 10
				8-7	8.9	24	7.6	4.0	average of 10
				8-27	1.2	22	7.3	2.3	50,000

No.	Waste Source	Miles	Sample Source	Date	B.O.D. mg/1	Temp. °C.	pH	D.O. mg/1	MFCC per 100 ml.
		13.6	Stiles Dam	8-7	--	--	--	1.1	Average of 3
				8-27	--	22½	7.1	7.8	--
				11-4	32.	8	7.2	2.4	40,000
		13.5	Old 141 Bridge	2-26	9.	2	7.3	7.2	6,600
				8-6	4.4	25	7.2	2.0	average of 10
				8-7	3.4	25	7.3	0.3	average of 10
				8-27	2.5	21½	7.5	5.0	10,000
				11-4	36.	8	7.2	2.3	29,000
		9.4	CTH "J" Bridge	2-26	6.3	1½	7.3	5.5	2,700
				8-6	3.7	--	--	--	average of 5
				8-7	3.1	--	--	--	average of 5
				8-27	3.4	23	7.9	9.2	1,700
				11-4	33.	8½	7.3	2.9	10,000
		3.6	Above Oconto (Park)						
				8-26	2.3	18½	7.7	6.4	5,000
				11-4	19.	9½	7.3	--	4,200
		3.1	U.S. 41 Bridge	1-29	5.8	1	7.2	3.5	2,100
				2-26	5.1	1½	7.3	1.7	1,500
				2-27	4.3	1	7.2	2.2	1,700
				3-20	5.2	2	7.2	7.5	2,500
				4-15	11.5	9	7.0	5.0	23,000
				5-8	4.0	10	7.4	5.5	1,400
				6-25	2.5	20	7.4	5.2	17,000
				7-16	3.4	28	7.4	3.5	2,000
				8-20	4.0	25	7.2	5.6	19,000
				8-26	7.8	20	7.4	6.4	8,000
				9-17	3.7	19	7.0	1.8	3,500
				10-15	1.2	19	7.6	4.4	2,100
				11-4	21.	9½	7.3	6.5	6,100
4	Oconto, City of	1.3	STP Outfall	2-26	37.	6½	7.5	7.0	--
				6-12	70. *	18	7.1	0.5	--
				8-26	2.8	18	7.7	--	--
				11-4	14.	11½	7.8	6.5	--
		1.0	Public Landing	2-26	5.9	1½	7.3	1.5	4,100
				8-26	2.1	20	7.8	5.9	39,000
				11-4	20.0	9½	7.3	2.1	29,000
			A. NORTH BRANCH OCONTO						
		50.5	Town Road Above	5-15	0.9	12½	8.3	9.5	3,400
				9-10	4.0	13	7.2	7.7	4,700
5	Wabeno, Uninc. Village of	49.8	CTH "H" Bridge	5-15	1.5	13½	7.5	9.1	62,000
				9-10	2.1	13	7.3	7.7	23,000

No.	Waste Source	Miles	Sample Source	Date	B.O.D. mg/l	Temp. °C.	pH	D.O. mg/l	MFCC per 100 ml.
		48.5	CTH "C" Bridge	5-15	1.2	13½	7.5	9.0	150,000
				9-10	2.4	13	7.3	7.8	80,000
			B. CHRISTIE BROOK						
		2.5	STH "22" Bridge above	8-27	<1.0	11½	8.1	9.8	5,100
		2.4	Town Rd. Above STP	4-10	3.1	5	7.8	11.7	400
				8-27	5.4	11½	8.2	9.4	>300,000
				9-5					1,400,000 EST
6	Gillett, City of	2.3	STP Outfall	4-10	6.0*	9	7.8	4.2	--
				8-27	18.0	14½	7.5	--	--
		2.3	75' Below STP Outfall	8-27	<1.0	11½	7.6	--	--
		2.2	200' Below STP	8-27	5.1	13	7.7	6.6	250,000
7	Country Gardens Inc., Gillett	2.1							
		0.9	Town Rd. Bridge Below	4-10	4.0	8½	8.0	11.6	11,000
				8-27	<1.0	13½	8.0	9.6	23,000
			C. LITTLE RIVER						
		8.7	CTH "A" Above Jones Creek	3-4	0.6	2½	7.5	6.5	600
				7-23	<1.0	21	8.1	4.5	4,000
				8-26	<1.0	19½	8.8	13.1	800
		7.8	Mouth-Jones Creek						
		6.4	CTH "J" Below Jones	2-22	2.0	1	7.2	5.1	10,000
				3-4	1.4	2½	7.5	4.7	74,000
				7-23	<1.0	21½	8.1	5.0	1,000
				8-26	<1.0	18½	8.4	10.5	300
			C.1 JONES CREEK						
		7.0	CTH "A" Above	2-22		No Flow			
				3-4		No Flow			
				7-23		No Flow			
				8-26		No Flow			

No.	Waste Source	Miles	Sample Source	Date	B.O.D. mg/l	Temp. °C.	pH	D.O. mg/l	MFCC Per 100 ml.
8	Lena, Village of	6.5	STP Outfall	2-22	>800.	6½	7.1	2.8	50,00 ,000
				3-4	475.	7½	7.1	2.5	--
				7-23	731.	20	7.2	2.2	--
				8-26	450.	19½	7.1	--	--
				* 11-19	86	--	7.6	--	--
9	Frigo Bros. Ch. Corp, Lena	6.1	Cooling Water Outfall	2-22	47.	14½	7.0	1.3	--
				3-4	24.	19	7.1	1.1	--
				7-23	26.	21	7.1	3.5	--
				8-26	4.9	26½	7.7	3.7	>300,000
				9-5	--	--	--	--	320,000
		6.0	US 141 Bridge	2-22	>242.	10.	7.0	1.2	15,000,000
				3-4	175.	13½	7.1	2.4	15,000,000
				7-23	156.	20	7.3	0.0	4,000,000
				8-26	170.	20½	7.1	0.0	5,800,000
		4.7	Town Road Bridge	2-22	>242.	1½	7.1	0.9	9,000,000
				3-4	138.	2	7.2	1.8	11,000,000
				7-23	87.	18	7.6	0.0	35,000,000
				8-26	12.	17	7.7	2.1	2,600,000
		2.8	CTH "J" Bridge	2-22	>242.	2	6.9	0.0	7,000,000
				3-4	175.	2	7.1	0.7	3,200,000
				7-23	8.2	19½	7.9	0.0	900,000
				8-26	6.8	17	8.0	12.1	30,000
		1.2	CTH "A" Culvert	2-22	>161.	1	7.0	0.0	2,100,000
				3-4	138.	2½	7.1	1.5	2,800,000
				7-23	<1.0	19	7.0	2.3	30,000
				8-26	9.2	17	7.7	14.7	7,000

* Denotes
composite sample

PESHTIGO RIVER DRAINAGE BASIN
1968

No.	Source or Stream	Miles	Type of Waste	Treatment	Est. Discharge to Stream per Day Gallons	Lbs. 5-Day B.O.D.
	PESHTIGO RIVER - MAIN STEM					
	Middle Br. Peshtigo River	111.6				
	Rat River	74.2				
	Middle Inlet Creek	32.1				
	Beaver Creek	27.0				
1	Riverside Ch. Fty. Rte. 1, Crivitz, Wis.	27.2	Milk	None	?	?
	Little Peshtigo River	23.2				
2	Badger Paper Mills., Inc., Peshtigo	10.4	Pulp & Paper	Lagoons & Land	5,510,000	16,140
3	Peshtigo, City of	10.0	Sewage	Secondary	558,600	205
	Green Bay	0.0				
	A. Middle Branch Peshtigo River					
	S. Br. Peshtigo River	5.6				
	Peshtigo River	0.0				
	1. South Branch Peshtigo River					
	Tributary	7.8				
	Mid. Br. Peshtigo River	0.0				
	a. Tributary					
4	Crandon, City of	0.3	Sewage	Secondary	0	0
	S. Br. Peshtigo River	0.0				

o.	Source or Stream	Miles	Type of Waste	Treatment	Est. Discharge to Stream per Day Gallons	Lbs. 5-Day B.O.D.
	B. Rat River					
	Laona, Uninc. Vil. of	22.3	Sewage	Lagoon	--	--
	Blackwell Job Corps. Center	17.5	Sewage	Secondary	?	?
	Peshtigo River	0.0				
	C. Middle Inlet Creek					
	Lower Mid. Inlet Creek	8.4				
	Peshtigo River	0.0				
	1. Lower Middle Inlet Creek					
	Smith Creek	1.0				
	Middle Inlet Creek	0.0				
	a. Smith Creek					
	Crivitz, Uninc. Vil. of	2.7	Sewage	Lagoon	0	0
	Lower Middle Inlet Creek	0.0				
	D. Beaver Creek					
	Tributary	8.6				
	Peshtigo River	0.0				
	1. Tributary					
3	Pound, Vil. of	1.1	Sewage	Secondary	47,900	6
	Beaver Creek	0.0				
	E. Little Peshtigo River					
	Spring Creek	18.0				
	Coleman, Vil. of	11.2	Sewage	Secondary	260,160	24

No.	Source or Stream	Miles	Type of Waste	Treatment	Est. Discharge to Stream per Day Gallons	Lbs. 5-Day B.O.D.
	a - Coleman Ch. Fty.		Milk			
	Tributary	10.1				
	Tributary	9.3				
	Peshtigo River	0.0				
			1. Spring Creek			
10	Springs[illegible] Ch. Fty. Rte. 1, Coleman, Wis.	3.0	Milk	Septic Tank	?	?
	Little Peshtigo River	0.0				
			2. Tributary			
11	Country Gardens, Inc. Coleman, Wis.	1.1	Canning	Spray Irrigation	?	?
	Little Peshtigo River	0.0				
			3. Tributary			
11	Country Gardens, Inc. Coleman, Wis.	1.5	Canning	Spray Irrigation	?	?
	Little Peshtigo River	0.0				

PESHTIGO RIVER DRAINAGE BASIN
1968

No.	Waste Source	Miles	Sample Source	Date	B.O.D. mg/l	Temp. °C.	pH	D.O. mg/l	MFCC per 100 ml.
			PESHTIGO RIVER - MAIN STEM						
		14.1	STH 64	9-5	3.7	21	8.2	8.4	1,800
		10.5	U. S. 41	2-27	<0.5	1	7.6	10.3	25,000
				3-14	2.5	1	7.4	9.9	20,000
				3-20	6.8	2	7.8	11.6	22,000
				4-15	2.2	9	7.4	10.4	11,000
				5-8	3.1	11	7.9	9.5	1,100
				6-25	0.6	19½	7.8	7.2	3,600
				7-16	4.6	27	7.8	5.8	600
				8-20	1.5	24	8.0	6.8	3,000
				9-17	<1.	20	7.6	7.2	92,000
				10-15	<1.	18	7.7	7.8	11,000
2	Badger Paper Mills	10.4	Outfalls						
		10.0+	Below	1-29	5.2	1	7.8	11.5	120,000
				9-5	1.2	21	7.7	7.4	6,000
			South Bank	9-5	1.5	20	7.8	7.5	6,900
			North Bank	9-5	1.1	21	7.2	6.8	260,000
3	Peshtigo, City of	10.0	STP Outfall	3-14	80.	--	7.6	--	--
				4-9	44. *	9½	7.6	6.9	--
				9-5	18.	--	--	--	--
		9.1	Average Cross-Section	9-17	9.3	18	7.38	6.93	--
		8.0	Average Cross-Section	9-18	14.1	18	7.4	5.72	--
		7.1	Average Cross-Section	9-18	5.81	19	7.4	6.17	--
		5.4	Average Cross-Section	9-17	7.29	18	7.4	6.40	--
		0.1	Above Mouth	3-14	11.	1	7.4	8.2	48,000
		0.0	Green Bay						

No.	Waste Source	Miles	Sample Source	Date	B.O.D. mg/l	Temp. °C.	pH	D.O. mg/l	MFCC per 100 ml.
A. 1. a. SOUTH BRANCH PESHTIGO RIVER TRIBUTARY									
4	Crandon, City of	0.3	Pond Outfall			No Effluent			
		0.0	Peshtigo Lake (So. Br. Peshtigo R)						
B. RAT RIVER									
5	Laona, Uninc.	22.3	Pond Outfall			Under Construction			
		0.0	Peshtigo River						
C. 1. a. SMITH CREEK									
7	Crivitz, Uninc.	2.7	Pond Outfall			No Effluent			
		0.0	Lower Middle Inlet						
D. 1. BEAVER CREEK TRIBUTARY									
		1.1+	Town Road Above						
				6-5	3.	19½	7.8	6.1	5,200
				9-5	1.2	20	8.2	7.7	41,000
				11-21	3.1	3	7.6	11.4	1,100
8	Pound, Vil. of	1.1	STP Outfall	6-5	15. *	13	7.7	3.2	--
				9-5	18.	17½	7.4	4.2	--
				11-21	13.	--	--	--	--
		0.9	STH 64 Below	6-5	7.	19	7.6	4.0	50,000
				9-5	8.2	19	7.9	4.4	--
				11-21	3.1	4	7.4	8.6	150,000
		0.0	Beaver Creek						
E. LITTLE PESHTIGO RIVER									
		11.2+	Above	6-5	3.	21	8.0	7.3	4,700
				9-5	<1.	18½	8.0	8.6	7,400
				9-30	<1.	17	8.4	10.3	2,400
9	Coleman, Vil. of	11.2	STP OUTFALL	6-5	43.*	14½	7.5	6.1	--
				9-5	35.	18	7.6	4.9	--
				9-30	109.	--	7.7	--	--

No.	Waste Source	Miles	Sample Source	Date	B.O.D. mg/l	Temp. °C.	pH	D.O. mg/l	MFCC per 100 ml.
		11.1	Below STP	6-5	2.5	23	8.0	7.5	80,000
				9-5	2.1	19	8.2	8.8	330,000
				9-30	3.1	17	8.4	10.4	1,500,000
		10.1+	Above Trib. # 1	9-30	1.4	19	8.4	11.2	54,000
		10.1	Trib. #1 Mouth						
		9.3	Trib. #2 Mouth						
		8.9	CTH B Below	6-5	2.5	22	8.0	7.4	30,000
				9-5	1.2	19	8.1	7.8	56,000
				9-30	3.4	16	8.0	2.0	4,800
		7.0	Adj. to CTH B.	9-30	2.3	18	8.4	9.1	1,900
		0.0	Peshtigo River						
		E. 2. LITTLE PESHTIGO RIVER TRIBUTARY							
11.	Country Gardens Inc.	1.1	Spray Area						
		0.7	CTH B	9-5	21.	16	7.2	2.5	--
				9-30	368.	16	6.4	1.3	--
		0.0	L. Peshtigo R.						
		E. 3. LITTLE PESHTIGO RIVER TRIBUTARY							
11.	Country Gardens Inc.	1.5	Spray Area						
		1.3	N-S Town Road	9-5	830.	18	4.8	0.0	--
				9-30	2710.	18	4.4	0.0	--
		0.3	CTH B	9-5	3.1	17.	7.2	4.0	--
				9-30	>218.	15	7.1	0.0	--
		0.0	L. Peshtigo R.						

* Composite Sample

MENOMINEE RIVER DRAINAGE BASIN
1968

No.	Source or Stream	Miles	Type of Waste	Treatment	Est. Discharge to Stream per Day Gallons	Lbs. 5-Day B.O.D.
	I. MENOMINEE RIVER - MAIN STEM					
	Brule River	114.3				
1	Kimberly-Clark Corp., Niagara	85.1	Pulp & Paper	Save-alls, Hauling	8,880,000	17,540
	Niagara, Vil. of	83.9	Sewage	Primary	?	?
	Pike River	48.5				
	Wausaukee River	42.3				
3	Scott Paper Co., Marinette	3.0	Pulp & Paper	Save-alls, Screening & Hauling	5,810,000	58,600
3	Scott Paper Co., Marinette	2.3				
4	Marinette, City of	1.2	Sewage	Primary	2,169,000	1,230
5	Ansul Chemical Co., Marinette	1.0	Chemical		?	?
	Lake Michigan	0.0				
	A. BRULE RIVER					
	Tributary					
	Menominee River	0.0				
	1. TRIBUTARY					
6	Florence, Uninc. Vil. of	2.4	Sewage	Lagoon	?	?
	Brule River	0.0				

					Est. Discharge to Stream per Day	
No.	Source or Stream	Miles	Type of Waste	Treatment	Gallons	Lbs. 5-Day B.O.D.
			B. PIKE RIVER			
	S. Br. Pike River					
	Menominee River	0.0				
			1. S. BRANCH PIKE RIVER			
	Chemical Creek					
	Pike River	0.0				
			a. CHEMICAL CREEK			
7	Goodman, Uninc. Village of		Sewage	Lagoon	?	?
	S. Br. Pike River	0.0				
			C. WAUSAUKEE RIVER			
8	Wausaukee, Vil. of	4.0	Sewage	Lagoon	0	0

MENOMINEE RIVER DRAINAGE BASIN
1968

No.	Waste Source	Miles	Sample Source	Date	B.O.D. mg/l	Temp. °C.	pH	D.O. mg/l	MFCC per 100 ml.
			I. MENOMINEE RIVER - MAIN STEM						
		85.2	Dam above	3-12	<0.5	½	7.0	11.0	7,500
		85.2		11-21	<1.	3	7.2	12.2	900
1	Kimberly-Clark Corp.	85.1	Outfall						
2	Niagara, Vil. of	83.9	STP Outfall	3-12	90.	--	7.3	--	--
		83.9		11-21	34.	--	--	--	--
		81.2	U. S. 8	3-12	2.5	½	7.2	12.7	37,000
		81.2		11-21	1.8	3	7.2	12.9	2,000
		77.7	Sturgeon Falls Dam	3-13	1.2	1	7.4	12.6	19,000
		77.7		11-21	2.1	3	7.2	12.7	800
		71.5	Faithorn R. R.	3-13	<0.5	0	7.5	12.6	5,700
		68.7	Kremlin Falls	11-21	3.7	3	7.2	13.1	1,800
		62.3	CTH 2	3-13	1.7	0	7.5	12.7	4,500
		62.3		9-16	1.1				
		54.5	CTH K	3-13	1.2	1	7.5	12.6	3,400
		3.5	Upper Dam	1-29	0.9	1	7.7	10.5	100
		3.5		2-27	<0.5	1½	7.6	11.5	470
		3.5		3-14	0.6	1	7.4	11.4	200
		3.5		3-20	1.1	1	7.7	11.1	700
		3.5		4-15	1.8	9	7.7	10.5	600
		3.5		5-7	3.1	11	7.6	9.7	420
		3.5		6-25	0.6	19	7.5	7.6	3,500
		3.5		7-16	<1.	27	7.5	6.4	900
		3.5		8-20	4.6	24	8.0	7.7	3,300
		3.5		9-16	1.4	18	7.2	8.3	600
		3.5		9-17	<1.	19	7.2	7.8	2,200
		3.5		10-15	<1.	17	7.7	8.8	540
3	Scott Paper Co.	3.0	Upper Mill Outfall						
		2.8	Below	9-16	4.5	18½	7.3	8.1	2,000

No.	Waste Source	Miles	Sample Source	Date	B.O.D. mg/1	Temp. °C.	pH	D.O. mg/1	MFCC per 100 ml.
3	Scott Paper Co.	2.3	Lower Mill Outfall						
		1.7	U. S. 41	3-14	7.1	1	7.5	11.7	2,600
		1.7		9-16	2.3	17½	7.4	8.4	5,000
4	Marinette, City of	1.2	STP Outfall	2-14	68. *	9	7.3	--	--
		1.2		3-14	38.	--	7.2	--	--
5	Ansul Chemical	1.0	Outfall	9-16	91.	27	9.6	--	--
5	Ansul Chemical	0.9	Outfall	9-16	>220.	32	2.9	--	--
5	Ansul Chemical	0.9	Outfall	9-16	62.	37	2.6	--	--
		0.3	Ogden Street	3-14	2.8	2	7.4	12.2	2,300
		0.3		9-16	1.6	17½	7.4	8.5	3,000
		0.0+	Mouth	9-16	1.4	17½	7.3	8.5	4,100
		0.0	Green Bay						
			A. 1. BRULE RIVER TRIBUTARY						
6	Florence, Uninc.	2.4	Pond Outfalls	9-17	1.8	18	7.4	1.7	2,000
		2.4		11-20	1.0	--	--	--	--
		1.7	Below	9-17	7.7	16	7.2	2.2	4,200
		0.0	Brule River						
			B. 1. a. CHEMICAL CREEK						
		43.3	Above	9-16	1.8	20	7.2	6.5	9,600
7	Goodman, Uninc.	43.2	Pond Seepage	11-20	14.	--	--	--	--
		42.2	Below	9-16	2.5	19	7.4	7.4	3,800
			C. WAUSAUKEE RIVER						
8	Wausaukee, V.I. of	4.0	Pond Outfall			No Effluent			
		0.0	Menominee River						

* Composite Sample

APPENDIX VI.

LOWER FOX, OCONTO, PESHTIGO AND MENOMINEE RIVERS - SURFACE WATER QUALITY DATA, 1950-1973

LOWER FOX RIVER

SUMMARY OF RESULTS OF COOPERATIVE STREAM SURVEYS
June - September

Stations	Discharge c.f.s. Maximum			Discharge c.f.s. Minimum			Miles	Dissolved Oxygen p.p.m. Maximum			Dissolved Oxygen p.p.m. Minimum			5 Day B.O.D. p.p.m. Maximum			Temperature Range °C		
	1950	1951	1952	1950	1951	1952		1950	1951	1952	1950	1951	1952	1950	1951	1952	1950	1951	1952
Neenah Channel							0.0	9.4	8.7	10.2	6.8	6.2	5.6	10.3	10.4	390*	16-24		15-25
Kaukauna							13.5	6.6	6.9	6.7	0.3	1.4	0.3	6.2	13.8	13.5	16-24	15-26	15.5-25
Wrightstown	3470	6380	6650	1650	1900	1730	20.0	5.7	4.8	6.0	0.0	0.0	0.0	8.6	14.2	14.9	16-24	15-25	14.5-2
De Pere Dam							29.0	5.1	4.7	4.5	0.0	0.0	0.0	20.6	11.4	8.1	17-25	16-25	15-25
G.B. & W.R.R. Br.							35.0	3.2	4.8	4.4	0.0	0.0	0.0	<26.1	13.[illegible]	17.4	17-25	15-26	15-26
	1953	1954	1955	1953	1954	1955		1953	1954	1955	1953	1954	1955	1953	1954	1955	1953	1954	1955
Neenah Channel							0.0	11.0	11.0	9.9	6.6	4.3	5.9	>100*	175*	14.4	15-26	16-25	15.5-2
Kaukauna							13.5	4.8	5.4	6.2	0.0	0.0	0.0	16.6	16.9	18.5	16-26	15-26	15.5-2
Wrightstown	3510	5530	5900	1650	1620	1190	20.0	1.6	6.1	6.5	0.0	0.0	0.0	14.8	13.8	20.5	15-26	14-27	15.5-2
De Pere Dam							29.0	7.9	8.2	9.1	0.2	0.0	0.0	9.1	20.7	9.1	17-28	16-27	16.5-2
G.B. & W.R.R. Br.							35.0	4.2	7.7	-	0.0	0.0	0.0	>12.8	17.7	22.4	18-26	18-27	16.5-2

* High B.O.D. value is due to large quantities of algae

1956 Date	Flow cfs	BOD_5 mg/l	D.O. mg/l	1957 Date	Flow cfs	BOD_5 mg/l	D.O. mg/l	1958 Date	Flow cfs	BOD_5 mg/l	D.O. mg/l	1959 Date	Flow cfs	BOD_5 mg/l	D.O. mg/l	1960 Date	Flow cfs	BOD_5 mg/l	D.O. mg/l
6-1	3,660	5.0	5.4	6-7	4,570	4.5	4.5	6-6	1,400	9.8	1.3	6-5	5,520	9.5	5.1	6-17	3,770	9.8	3.6
6-8	3,120	6.6	4.3	6-14	5,170	3.9	2.8	6-13	1,360	10.9	0.8	6-12	4,180	4.1	3.4	7-1	4,600	4.9	3.3
6-15	3,060	4.8	2.1	6-28	3,270	11.2	1.2	6-20	1,270	8.9	0.7	6-19	2,550	6.4	3.3	7-8	3,750	4.3	8.0
6-22	3,280	14.4	2.8	7-12	1,990	11.2	1.3	6-27	1,260	14.4	0.6	6-26	2,360	4.6	0.5	7-22	4,160	16.0	0.4
7-6	3,040	6.0	5.2	7-26	2,400	12.7	1.7	7-2	1,340	15.0	0.7	7-10	1,990	50.8	1.1	8-12	4,160	10.9	1.8
7-13	3,390	9.6	2.5	8-9	1,980	18.5	0.1	7-11	1,440	10.4	1.2	7-17	1,610	5.2	0.6	8-19	4,000	6.0	3.4
7-27	3,340	5.4	2.2	8-16	1,830	13.1	0.9	7-18	1,650	16.8	0.6	7-21	1,980	16.6	0.4	8-26	6,690	14.5	5.3
8-3	3,390	1.0	2.6	8-22	1,660	16.0	0.9	7-25	1,480	11.5	0.0	7-24	1,680	25.8	0.2	9-2	5,940	11.2	2.4
8-10	3,400	4.3	1.9	8-29	1,650	8.0	1.0	8-1	1,250	5.7	0.6	8-7	1,390	23.9	0.2	9-9	4,360	7.9	4.4
8-17	3,450	6.5	1.5	9-6	1,730	10.3	0.8	8-8	1,220	23.2	0.0	8-14	1,750	7.5	0.2	9-16	3,980	5.0	4.0
8-24	5,560	4.0	5.6	9-13	1,650	29.8	0.8	8-15	1,150	6.5	0.5	8-21	1,880	14.0	0.5	9-23	4,400	13.8	3.2
8-31	3,190	10.8	3.3	9-20	1,520	12.9	0.8	8-22	942	13.8	1.9	8-28	1,800	4.3	0.7				
9-14	2,610	21.6	1.6	9-26	1,560	20.1	0.[illegible]	9-5	1,190	9.0	0.9	9-11	1,720	8.8	0.7				
9-21	2,930	11.0	3.3					9-12	1,350	28.2	0.3	9-25	1,890	9.6	0.9				
9-28	2,560	1.9	1.6					9-19	1,360	22.1	0.5								
								9-26	1,940	22.8	0.6								

Fox River Station at Green Bay and Western Railroad Bridge, Green Bay.
Flow data from U.S.G.S. gaging station at Rapid Croche Dam, near Wrightstown, Wisconsin.

Source: Fox River – Highway 54 (Mason Street) Bridge at Green Bay

Year: 1961-62

	LABORATORY ANALYSIS																	FIELD DATA		
Date	Alkalinity Phth. ($CaCO_3$)	Alkalinity Total ($CaCO_3$)	Bacteriological (M.P.N.) per 0.1 ml.	B.O.D. (5-Day)	Chlorides	Color	Hardness (Total)	Nitrogen: Total Organic	Free Ammonia	Nitrates	pH	Phosphorus (Total)	Phosphorus (Sol.)	Solids: Total	Volatile	Solids: Suspended	Volatile	D.O.	pH	Temperature (°C.)
1961																				
4-11	0	150	24	1.9	0	60	181				7.7			242	102	13	6	11.95	7.6	6
4-27	0	142		3.9	0	50	184				7.0			292	118	23	6			
5-16	0	154	36	3.2	9.0	35	186				7.5			276	126	10	6	3.2	7.5	16
6-27	0	156	4.6	0.8	1.0	40	194				7.5			304	130	8	7	2.2	7.4	20
7-25	0	155	4.3	5.0	12.0	45	180	1.62	.25	<.12	7.8	.18	.04	278	132	21	11	1.6	7.4	22
8-22	0	147	140	6.7	10.5	40	170				7.7			264	116	17	9	3.4	7.6	22.5
9-20	0	150	24	4.1	10	40	176				7.7			264	122	13	10	4.9	7.6	18.5
10-24	0	147	15	5.9	9.0	40	172				7.7			258	106	10	8	5.0	7.2	10
11-28	0	147	43	3.7	5.0	20	168	1.19	.07		8.0			242	102	18	10	12.8	7.6	1
12-21*	0	148	110	9.2	8.0	30	176				7.8			266	138	9	2	12.3	7.6	1
1962																				
2-1*	0	161	43	8.5	8.0	43	183	.81	.07	.24	6.8	.14	.02	256	122	9	5	11.7	7.2	1
3-6*	0	166	9.3	7.4	9.5	45	190				7.4			294	124	10	7	8.3	7.4	1
3-28	0	118	240	8.3	6.5	80	156				7.3			360	110	100	12	10.9	7.4	6
4-25	0	161	2.4	6.2	5.5	35	188	1.03	.08	.22	8.25	.24	.03	250	76	24	17	11.8	7.8	12
5-28	0	147	24	2.8	7.0	37	172				7.7			238	80	9	8	5.2	7.5	17
7-2	0	146	4.3	6.4	0.0	45	172				7.35			276	86	21	16	2.1	7.4	23
7-24	0	138	24	6.3	11.5	45	174	1.48	0.21	0.13	7.40	0.28	0.05	246	76	16	11	0.3	7.4	23
9-4	0	122	43	4.4	14	45	166				7.25			250	102	11	7	3.6	7.4	23
9-25	0	130	24	5.3	10.5	43	172				7.35			316	104	22	15	3.9	7.2	15
10-31		138	24	6.2	8.5	30	168	1.03	0.08	0.28	7.35	.16	.06	250	104	15	7	8.5	7.5	7
11-29		140	43	8.3	9.0	25	168				7.25			240	112	11	11	9.8	7.6	3
12-19*		152	24	5.0	7.0	23	170				8.10			230	98	10	4	11.2	7.4	1
Mean		146		5.4	7.5		176	1.19	.12	.19		.20	.05					6.9		
Max.	0	166	240	9.2	14	80	194	1.62	.25	.28	8.25	.28	.06	360	138	100	17	12.8	7.8	23
Min.	0	118	2.4	.8	0	20	156	.81	.07	<.12	6.8	.14	.02	230	76	8	2	.3	7.2	1

*Winter samples taken at De Pere.

Concentrations expressed as mg/l unless otherwise indicated.

Source: Fox River - Highway 54 Bridge at Green Bay

Year: 1963-64

Date	LABORATORY ANALYSIS																		FIELD DATA		
	Alkalinity Phth. ($CaCO_3$)	Alkalinity Total ($CaCO_3$)	Bacteriological per 0.1 ml.	B.O.D. (5-Day)	Chlorides	Color	Hardness (Total)	Nitrogen: Total Organic	Free Ammonia	Nitrates	pH (s.u.)	Phosphorus (Total)	Phosphorus (Sol.)	Solids: Total	Volatile	Solids: Suspended	Volatile	ABS	D.O.	pH (s.u.)	Temperature °C.
1963		166	43	9.1	9.5	50	184	.92	.10	.32	7.7	.18	.06	266	120	13	6	.12	10.4	7.4	0
2-27*		174	24	8.1	10	30	194				7.6			280	130	3	2	.18	6.6	7.4	1
3-27		122	460	12.2	10	60	152				7.4			298	98	74	16	.16	11.0	7.4	3
4-30		141	9.3	8.6	10	35	162	1.69	.11	.24	8.15	.20	.05	252	90	37	20	.15	8.1	8.0	11
5-23		144	2.4	2.9	8	30	160				8.0			222	94	7	1	.16	6.1	7.4	12
6-25		152	2.4	4.3	12	40	180				7.45			266	130	6	6	.16	.5	7.2	23
7-30		144	9.3	8.9	12.5	55	164	3.07	.19	.12	7.7	.38	.04	292	134	35	21	.14	4.0	7.6	25
8-28		158	46	8.7	18.5	100	184				7.8			320	158	31	21	.14	3.7	7.3	21½
10-2		142	43	6.7	20	50	176				7.4			300	206	15	12	.20	3.2	7.3	17½
10-30		154	1100	6.5	18	40	182	1.70	.35	.28	7.4	.26	.04	290	140	14	12	.12	.2	7.4	13
11-26		150	15	7.4	16	30	178				7.5			282	128	4	4	.16	5.0	7.3	4
12-12		148	9.3	13.9	16	35	180				7.2			264	102	12	5	.12	7.9	7.4	½
1964																					
1-30		168		8.6	10.5	35	192	.98	.16	.20	7.4	.20	.09	270	148	6	4	.08	10.2	7.4	½
2-26		170	5.0	10.8	9	35	192				7.45			266	132	10	10	.12	8.1	7.4	0
3-31		163	2.2	8.7	18.5	55	200				7.2			298	128	10	10	.18			
5-5		162	31	6.6	20	40	200	1.18	.19	.40	7.3	.20	.05	316	136	13	13	.12	0.2	7.2	17½
5-27		156	3.2	3.6	16	25	176				7.15			240	78	10	6	.06	2.7	7.4	19½
6-18		163	15	3.7	13	35	192				7.35			266	114	14	7	.24	1.6	7.4	21½
7-22		142	31	8.0	17	80	184	2.00	.43	<.28	6.95	.28	.03	282	194	21	16	.16	2.4	7.4	28
9-1		145	4.0	10.8	18	45	172				7.6			282	128	16	13	.18	6.9	7.6	23
9-24		142	12	7.1	17.5	35	196				7.35			278	120	15	8	.08	.1	7.2	16
10-20		142	24	6.4	17	30	244	1.11	.09	.20	7.1	.16	.03	270	116	14	14	.08	3.1	7.4	10
12-1		144	23	13.4	16.5	28	178				7.3			270	104	20	16	.25	9.8	7.4	½
Mean		151		8.0	14.6		183	1.68	.22	<.35		.24	.05					.15	4.8		
Max.	0	174	1100	13.9	20	100	244	3.07	.43	.40	8.15	.38	.09	320	206	74	21	.25	11.0	8.0	28
Min.	0	122	2.2	2.9	8	25	152	.98	.09	.12	6.95	.16	.03	222	78	3	1	.06	.1	7.2	0

*Winter samples taken at De Pere.

Concentrations expressed as mg/l unless otherwise indicated.

Source : Fox River-Highway 54 Bridge at Green Bay*

Year:1965-66

	LABORATORY ANALYSIS																		FIELD DATA		
Date	Alkalinity Phth. ($CaCO_3$)	Alkalinity Total ($CaCO_3$)	Bacteriological per 0.1 ml.	B.O.D. (5-Day)	Chlorides	Color	Hardness	Nitrogen: Total Organic	Free Ammonia	Nitrates	pH (s.u.)	Phosphorus Total	Phosphorus Sol.	Solids: Total	Volatile	Solids: Suspended	Volatile	MBAS	D.O.	pH (s.u.)	Temperature °C.
1965																					
*1-5	0	154	18	11.9	12	25	182				7.2			272	118	17	9	.04	9.0	7.4	½
*1-26	0	160	31	14.2	14	40	196	.94	.29	.32	7.9	.32	.18	280	126	2	2	.19	8.7	7.6	½
*2-25	0	164	60	8.2	12	20	190				7.7			260	118	5	5	.09	11.4	7.6	1
3-30	0	155	3.6	4.3	7	20	184				7.7			240	106	12	12	.1	11.7	7.6	4½
4-27	0	150	7.0	6.2	9	25	184	1.21	.18	.24	7.4	.24	.05	252	94	38	12	.08	10.4	7.4	7
6-7	0	137	2.8	3.2	11	32	156				7.6			226	92	12	12	.07	6.0	7.2	21
6-29	0	144		3.7	13	35	170				7.7			272	102	11	9		3.6	7.3	24
8-3	0	134	58	5.3	19	45	160	1.58	.52	.48	7.6	.3	.05	260	112	17	13	<.03	0.2	7.2	21
8-24	0	132	5.3	8.1	19	60	164				7.2			276	124	19	15		0.9	7.2	23
9-27	0	138	16	5.5	10	30	160				7.65			246	106	21	12	.1	7.6	7.3	12½
11-2	0	140	14	4.4	9	25	162	.9		.2	7.5	.08	.02	224	96	20	4	.06	9.7	7.4	8
11-30	0	140	14	4.0	10	35	170				7.5			242	100	25	5	.04	13.1	7.5	0
*12-28	0	146	46	.9	6	25	170				8.2			224	94	13	6	<.03	13.9	7.6	0
1966																					
*2-3	0	156	73	2.8	10	30	188	1.02	.08	.24	7.2	.12	.06	254	148	14	9	.03	10.2	7.4	½
*2-24	0	152	35	4.4	8	25	180				7.35			234	98	10	3	.04	12.8	7.5	0
3-29	0	124	16	4.1	8	45	166				7.6			232	96	30	11	.04	13.1	7.7	3½
4-28	0	125	9	4.6	13	25	188	1.19	.12	.08	7.45	.14	<.01	252	102	22	11	.04	7.7	7.4	9
5-31	0	142	3.5	2.4	13	35	172				7.2			240	74	7	3		4.3	7.4	17½
6-29	0	144	12	3.4	14	35	176				7.3			250	116	12	6	.06	1.7	7.2	26½
7-29	0	120	25	7.1	16	35	164				7.4			262	104	21	15	<.03	2.2	7.3	27
8-31	0	136	130	5.2	20	45	172	3.5	.37	.44	7.45	.318	.04	288	148	12	12	.05	0.1	7.2	23
9-28	0	146	16	6.9	23	50	196				7.2			308	144	13	12	.08	3.5	7.3	15
11-2	0	144	21	6.8	24	43	192				6.9			318	130	22	16	.06	4.5	7.2	6
11-30	0	138	34	7.8	17	30	172				7.2			322	148	17	10	.06	10.6	7.4	1½
*12-12	0	149	71	9.2	17	30	172				7.0			278	74	16	6	.06		7.4	1
Mean	0	149		6	13.9		183	1.29	.23	.29		.22	<.06					<.07	7.7		
Max.	0	164	130	14.2	24	60	196	3.5	.52	.48	8.2	.32	.18	322	148	38	16	.19	13.9	7.7	27
Min.	0	120	2.8	.9	6	20	156	.9	.05	.08	6.9	.08	<.01	224	74	2	2	<.03	<.1	7.2	0

*Winter samples taken at De Pere Dam
Concentrations expressed as mg/l unless otherwise indicated.

Source : Fox River-Highway 54 Bridge at Green Bay* Year: 1967 - 68

Date	LABORATORY ANALYSIS																		FIELD DATA		
	Alkalinity Phth. ($CaCO_3$)	Alkalinity Total ($CaCO_3$)	Bacteriological per 0.1 ml.	B.O.D. (5-Day)	Chlorides	Color	Hardness	Nitrogen: Total Organic	Free Ammonia	Nitrates	pH (s.u.)	Phosphorus Total	Phosphorus Sol.	Solids: Total	Volatile	Solids: Suspended	Volatile	MBAS	D.O.	pH (s.u.)	Temperature °C.
1967																					
* 2-1	0	142	56	5.4	11	20	176	.91	.14	.2	7.3	.14	.033	236	110	7	5		10.6	7.4	½
* 2-28	0	149	32	5.4	10	20	180				7.2			240	108	4	2		10.7	7.5	5
4-13	0	132	16	7.4	8	20	164	1.6	.096	.24	7.35	.40	.03	250	116	55	20		10.7	7.8	1
6-1	0	144	18	2.5	15	25	170				7.4			260	110	14	6		4.6	7.4	18½
6-29	0	124	28	1.8	9	28	164				7.2			242	76	17	4		5.2	7.6	21
7-26	0	140	17	6.3	17	45	172	1.93	.46	.14	7.45	.36	.06	300	118	14	3	.08	7.2	7.3	31
9-13	0	98	12	.6		30	108				7.1			142	56	11	8		7.0	7.8	21
10-18	0	138	9	4.	19	40	176	1.03	.49	.16	7.0	.14	.04	268	72	8	3	.08	2.0	7.4	12
11-29	0	142	54	8.6	12	25	172				7.3			256	106	21	7		12.7	7.8	1
12-18	0	140	43	4.2	13	30	178				7.4			262	112	15	6		12.1	7.6	1½
1968																					
*1-24	0	146	39	5.2	12	35	184	1.01	.30	.18	7.45	.182	.074	258	104	8	4	.08	10.2	7.6	½
*2-26	0	150	50	4.5	16	40	192				7.2			276	76	6	2		8.3	7.4	1
*3-21	0	154	17	5.5	17	35	184				7.8			282	116	21	9		8.6	7.8	6
*4-15	0	146	3.9	7.9	24	45	192	1.34	.26	.16	7.5	.20	.026	318	116	15	13	.04	2.2	7.2	11
5-7	0	138	11	4.9	17	30	164				7.7			240	104	16	5		7.7	7.6	12
6-25	0	132	3.6	3.2	15	30	176				7.9			274	76	26	7		2.7	7.6	22
7-16	0	138	1.2	8.0	9	35	170	1.40	.10	.16	7.8	.24	.031	260	116	23	13	.08	5.2	8.4	27
8-20	0	130	2.4	4.9	14	25	164				7.7			270	94	30	16		4.7	7.5	25
9-17	0	140	23	5.2	17	45	172				7.6			270	96	24	14		5.6	7.6	21
10-15	0	142	4.9	3.1	12	25	168	1.02	.29	.12	7.9	.18	.03	238	106	13	5	<.04	6.5	7.8	18
11-26	0	148	11.0	4.0	13	20	180				7.8			240	100	11	4		9.8	7.6	4
12-17	0	150	31.0	3.5	12	25	184				7.7			260	74	15	6		11.7	7.6	1
Mean		139		4.8	13.9		172	1.28	.27	.17		.23	.04						7.5		
Max.		154	56	8.6	24	45	192	1.93	.49	.24	7.9	.40	.074	318	118	55	20	.08	12.7	8.4	31
Min.		98	1.2	0.6	8	20	108	.91	.096	.12	7.0	.14	.026	142	56	4	2	<.04	2.0	7.2	½

Drainage Area = approx. 6,350 sq. miles

*Winter samples taken at De Pere Dam
Concentrations expressed as mg/1 unless otherwise indicated.

STORET SECONDARY CODE 1100230

SOURCE- FOX RIVER MASON ST BRIDGE GREEN BAY

DATE	ALKALINITY TOTAL	FECAL COLIFORM	5 DAY BOD	CHLORIDES	COLOR	HARDNESS	--------NITROGEN-------- TOTAL ORG	AMMONIA	NITRATES	TOTAL PHOSPHORUS	-----SOLIDS----- TOTAL	SUS	VOL SUS	---FIELD DATA--- D O	PH	TEMP CENT
1-28-69	152	1700	3.1	13.0	20	190	.80	.29	.24	.16	254	6	3	11.5	7.6	1
2-18-69	152	350	1.8	10.0	30	190					240	6	4	10.9	7.5	1
3-18-69	162	60	6.4	15.5	30	200	1.10	.09	.16	.16	240	16	8	10.8	7.9	4
4-15-69	148	25	4.0	8.0	20	172					242	22	8	11.3	8.4	9
5-20-69	137	75	4.0	11.0	30	166	.88	.20	.10*	.13	232	14	5	7.6	7.3	14
6-25-69	145	200	7.5	14.5	30	176					264	22	8	4.4	7.7	13
7-23-69	138	100	4.3	9.0	25	166	1.34	.29	.08	.32	220	70	17	5.3	7.4	25
8-13-69	142		3.5	15.0	30	180					282	26	4	3.3	7.7	25
9-10-69	144	75	8.0	19.5	40	180	2.62	.22	.20*	.46	318	47	28	2.3	7.7	20
10-08-69	150	30	4.5	20.0	35	184					298	15	7	3.0	7.4	16
11-18-69	144	320	7.5	13.0	30	176	1.04	.12	.12	.16	256	11	3	9.7	7.5	5
12-16-69	182	250	5.0	16.0	35	184					264	12	7	6.9	7.5	1
* MEAN	150		5.0	13.7	30	180	1.30	.20	.15	.23	259	23	9	7.4	7.7	12
1-14-70	156	2200	4.5	10.0	30	186	1.09	.09	.12	.28	254	7	3	10.6	7.7	1
2-18-70	162	90	3.0	10.5	30	192					254	4	1	10.0	7.2	1
3-10-70	148	15	3.5	17.0	40	188	1.07	.21	.17	.20	268	12	4	8.2	7.5	1
4-14-70	174	5*	17.0	20.0	30	200					326	38	21	10.6	8.6	7
7-29-70	150	5	8.5	20.0	50	180	3.00	.31	.12	.03	288	24	20	4.9	7.7	27
12-15-70	152		3.0	12.0	25	176	.76	.07	.12	.16	248	24	3	11.7	8.2	1
* MEAN	157		6.6	14.9	34	187	1.48	.17	.13	.17	273	19	[illegible]	9.3	7.4	6
3-24-71	164	140	3.5	11.5	25	192	.65	.10	.48	.12	234	11	4	13.8	7.8	2
7-07-71	144	75	3.0	16.0	30	176	2.44	.49	.19	.26	262	20	10	7.7	7.8	26
9-15-71	142	20	7.1	19.0	45	180	1.70	.08	.08	.23	240	28	19	5.6	7.4	20
11-03-71	154	55	4.6	18.0	30	176	1.13	.24	.08	.13	275	14	3	7.7	7.8	10
11-16-71	148	180	3.1	11.0	25	172	.93	.05	.16	.10	262	12	8	9.7	7.8	7
* MEAN	150		4.3	15.1	31	179	1.37	.19	.20	.17	265	17	8	8.9	7.8	13
1-19-72	160	30	5.5	11.0	25	184				.09	234	7	1	8.3	7.8	1
2-17-72	164	15	4.9	13.0	25	200	.92	.05	.17	.10	246	6	5	11.5	7.6	1
3-22-72	94	200	9.8	14.0	50	194	1.70	1.10	.12	.33	274	44	23	9.5	7.8	3
4-20-72	174	415	3.7	14.0	25	202	.92	.05	.24	.15	200	21	11	9.8	7.4	8
5-23-72	144	30	5.0	17.0	30	164	1.40	.31	.07	.16	246	13	8	.0	7.3	24
6-21-72	146		5.6	16.0	40	170	1.40	.54	.16	.17	256	14	4	.9	7.3	19
7-18-72	150	60	6.1	17.0	35	162	.50	.30	.08	.20	260	15	12	3.4	7.3	25
8-23-72	142	75	9.8	20.0	40	212	2.60	.08	.10	.31	326	64	22	4.1	7.8	23
9-19-72	140	80	6.1	11.0	30	156	1.36	.06	.08	.30	270	2	2	6.3	8.8	20
10-24-72	133	1200	5.2	11.0	65	162	1.14	.07	.07	.27	266	42	7	11.0	8.0	5
11-28-7	144	500	3.7	10.0	35	168	.96	.08	.09	.14	232	11	4	11.2	8.3	3
12-28-7	152	1500	1.8	22.0	30	196	1.07	.24	.24	.19	238	5	5	12.6	7.4	1
* MEAN	146		5.6	14.7	36	177	1.27	.26	.13	.20	259	20	9	7.6	7.7	11
** MEAN	150		5.4	14.4	33	180	1.33	.22	.15	.20	262	20	9	8.0	7.7	11

* ANALYSIS WAS LESS THAN FIGURE SHOWN

Concentrations expressed as mg/l unless otherwise indicated.

STORET SECONDARY CODE 1100000

SOURCE- FOX RIVER MASON ST BRIDGE GREEN BAY

DATE	ALKALINITY TOTAL	FECAL COLIFORM	5 DAY BOD	CHLORIDES	COLOR	HARDNESS	-------NITROGEN-------			TOTAL PHOSPHORUS	-----SOLIDS-----			---FIELD DATA---		
							TOTAL ORG	AMMONIA	NITRATES		TOTAL	SUS	VOL SUS	D O	PH	TEMP CENT
1973																
1-23	148	1000	5.5	12.0	40	176	.80	.26	.25	.13	232	9	2	10.0	7.4	0
2-14	158	700	4.3	1.0	35	188	.79	.12	.14	.09	246	6	1	11.5	7.1	1
3-28	160	10	3.4	8.0	50	184	1.08	.05	.24	.20	274	47	12	11.9	8.4	5
4-30	122	30	2.7	7.0	50	148	1.71	.02	.19	.16	244	54	12	10.2		12
5-24	122	70	2.2	7.0	40	152	.85	.17	.07	.09	222	24	3	8.4	7.9	18
6-28	140	600	4.0	12.0	50	160	1.20	.26	.24	.21	264	38	11	6.3	7.8	22
7-27	144	160	4.3	18.0	50	170	1.53	.41	.10	.22	308	37	6	4.6	6.9	25
9-20	150	700	4.3	21.0	45	168	2.04	.13	.06	.20	272	24	10	7.3	8.1	14
10-24	144	170	4.0	14.0	30	38	1.25	.31	.09	.15	278	16	5	7.9	7.8	14
11-29	150		4.0	11.0	30	168	.93	.05	.09	.09	234	9	5	11.0	8.0	30
12-18	154	750	5.5	13.0	30	180	.91	.06	.13	.08	246	15	8	4.1	7.9	22
MEAN	145		4.0	11.3	41	157	1.19	.17	.15	.15	256	25	7	8.5	7.7	15
MAX	160	1000	5.5	21.0	50	188	2.04	.41	.25	.22	308	54	12	11.9	8.4	30
MIN	122	10	2.2	1.0	30	38	.79	.02	.06	.08	222	6	1	4.1	6.9	0

Concentrations expressed as mg/l unless otherwise indicated

LOWER FOX RIVER FLOW DATA CORRESPONDING TO DATES OF SURFACE WATER QUALITY SURVEYS 1961-1973*

1961	
DATE	FLOW CFS
4-11	9,940
4-27	7,560
5-16	3,800
6-27	3,520
7-25	2,410
8-22	2,910
9-20	3,400
10-24	[illegible]
11-28	[illegible]
12-21	[illegible]

1962	
DATE	FLOW CFS
2-1	4,680
3-6	4,290
3-28	7,140
4-25	13,400
5-28	5,370
7-2	3,560
7-24	3,190
9-4	2,260
9-25	2,830
10-31	3,690
11-29	3,370
12-19	3,330

1963	
DATE	FLOW CFS
2-27	2,360
3-27	6,420
4-30	2,900
5-23	3,510
6-25	2,440
7-30	1,870
8-28	1,820
10-2	1,370
10-30	1,540
11-26	1,910
12-12	1,960

1964	
DATE	FLOW CFS
1-30	2,920
2-26	2,500
3-31	1,480
5-5	2,620
5-27	3,320
6-18	2,710
7-22	1,770
9-1	1,520
9-24	1,930
10-20	2,340
12-1	2,450

1965	
DATE	FLOW CFS
1-5	2,110
1-26	2,020
2-25	3,690
3-30	6,100
4-27	12,300
6-7	4,830
6-29	2,480
8-3	1,670
8-24	1,730
9-27	4,660
11-2	5,600
11-30	5,220
12-28	9,310

1966	
DATE	FLOW CFS
2-3	3,200
2-24	7,830
3-29	14,200
4-28	3,770
5-30	3,720
6-29	3,080
7-29	1,660
8-31	1,540
9-28	1,310
11-2	2,000
11-30	2,460
12-12	2,440

1967	
DATE	FLOW CFS
2-1	3,210
2-28	4,590
4-13	11,100
6-1	2,520
6-29	7,240
7-26	2,870
9-13	1,630
10-18	1,360
11-29	3,970
12-18	3,510

1968	
DATE	FLOW CFS
1-24	2,110
2-26	3,390
3-21	2,160
4-15	1,260
5-7	9,170
6-25	4,180
7-16	5,070
8-20	2,940
9-17	2,910
10-15	4,050
11-26	3,480
12-17	4,020

1969	
DATE	FLOW CFS
1-28	6,020
2-18	5,690
3-18	3,740
4-15	10,700
5-20	7,040
6-25	3,390
7-23	12,900
8-13	2,230
9-10	1,380
10-8	1,390
11-18	3,890
12-16	3,010

1970	
DATE	FLOW CFS
1-14	5,060
2-18	3,950
3-10	3,4[illegible]0
4-14	1,180
7-29	1,440
12-15	3,340

1971	
DATE	FLOW CFS
3-24	7,740
7-7	2,170
9-15	1,480
11-3	4,340
11-16	3,770

1972	
DATE	FLOW CFS
1-19	3,640
2-17	3,110
3-22	6,360
4-20	6,140
5-23	2,330
6-21	2,270
7-18	2,000
8-23	2,300
9-19	7,070
10-24	6,770
11-28	2,990
12-28	3,975

1973	
DATE	FLOW CFS
1-23	7,840
2-14	7,665
3-28	16,905
4-30	12,772
5-24	14,620
6-28	4,770
7-27	2,320
9-20	2,040
10-24	2,910
11-29	4,860
12-18	4,415

*FLOW DATA FROM U.S.G.S. GAGING STATION AT RAPID CROCHE DAM NEAR WRIGHTSTOWN, WIS.

OCONTO RIVER

SUMMARY OF RESULTS OF COOPERATIVE STREAM SURVEYS
June - September

Stations	Discharge c.f.s.						Miles	Dissolved Oxygen p.p.m.						5 Day B.O.D. p.p.m.			Temperature Range °C		
	Maximum			Minimum				Maximum			Minimum			Maximum					
	1950	1951	1952	1950	1951	1952		1950	1951	1952	1950	1951	1952	1950	1951	1952	1950	1951	1952
Oconto Falls	710	1140	932	255	346	268	0.0	9.0	8.7	9.0	6.5	5.7	5.7	2.5	1.5	1.9	14-24	14-25	14-25.
Stiles							7.0	3.6	5.0	5.2	0.0	0.0	0.0	19.1	27.0	20.1	15-25	15-27	15-26.

Stations	Discharge c.f.s.						Miles	Dissolved Oxygen p.p.m.						5-Day B.O.D. p.p.m.			Temperature Range °C		
	Maximum			Minimum				Maximum			Minimum			Maximum					
	1953	1954	1955	1953	1954	1955		1953	1954	1955	1953	1954	1955	1953	1954	1955	1953	1954	1955
Oconto Falls	848	1400	668	247	231	185	0.0	9.3	8.4	8.6	5.9	5.9	4.4	1.3	2.7	2.1	15-26	14-26	14.5-2
Stiles							7.0	3.5	5.1	3.8	0.0	0.2	0.0	23.5	17.8	21.5	15-27	14-26	15.5-2

1956				1957				1958				1959				1960			
Date	Flow cfs	BOD$_5$ mg/l	D.O. mg/l	Date	Flow cfs	BOD$_5$ mg/l	D.O. mg/l	Date	Flow cfs	BOD$_5$ mg/l	D.O. mg/l	Date	Flow cfs	BOD$_5$ mg/l	D.O. mg/l	Date	Flow cfs	BOD$_5$ mg/l	D.O. mg/l
6-8	292	2.6	2.4	6-5	424	2.5	3.9	6-4	362	2.2	5.2	6-3	812	2.6	5.3	6-2	1,060	-	6.6
6-15	244	3.8	2.8	6-14	334	2.6	-	6-11	522	3.6	4.2	6-10	398	1.5	2.4	6-8	802	-	3.6
6-22	593	2.4	2.3	6-19	428	4.4	2.2	6-18	326	3.0	2.5	6-17	296	2.2	3.7	6-10	723	6.1	3.5
6-29	881	2.3	4.4	6-26	272	2.4	2.4	6-25	398	3.7	2.2	6-24	292	0.5	2.4	6-15	637	-	3.9
7-6	429	1.9	3.1	7-3	240	2.9	4.7	7-2	582	2.0	3.2	7-1	300	2.0	4.0	6-22	796	1.2	4.9
7-13	559	1.4	2.8	7-10	326	3.8	6.4	7-9	1,020	1.6	4.4	7-8	292	1.5	6.1	6-29	1,070	1.7	4.5
7-20	534	2.9	4.8	7-17	306	0.9	4.0	7-16	513	2.0	3.0	7-15	292	1.4	3.6	7-6	728	9.4	4.8
7-27	584	2.0	3.2	7-24	278	1.6	3.6	7-23	358	1.3	2.0	7-22	289	1.0	3.0	7-13	513	1.5	3.2
8-3	342	2.5	2.3	7-31	278	2.7	3.2	7-30	278	1.8	3.2	7-29	213	1.0	3.2	7-20	485	9.2	2.6
8-10	415	2.3	3.1	8-7	195	2.1	4.0	8-6	225	0.5	2.8	8-5	205	2.1	4.3	7-27	770	1.8	1.9
8-17	342	2.3	3.6	8-14	254	1.9	1.2	8-13	532	1.2	1.5	8-12	228	2.5	3.2	7-29	657	-	2.0
8-24	264	2.1	5.8	8-21	244	2.0	3.2	8-20	289	2.3	2.9	8-19	286	1.8	3.1	8-3	765	-	2.7
8-31	274	2.1	3.0	8-28	286	1.6	4.5	8-27	286	3.8	3.4	8-26	472	2.2	3.2	8-10	1,050	0.5	2.7
9-7	342	2.1	6.0	9-4	557	1.5	4.4	9-3	303	1.6	4.1	9-2	517	0.8	3.2	8-17	823	2.0	3.5
9-14	268	3.4	4.4	9-11	338	2.0	4.8	9-10	807	1.6	4.6	9-9	350	2.2	2.5	8-24	698	1.1	2.4
9-21	240	4.1	6.8	9-18	547	3.8	4.2	9-17	362	1.8	3.1	9-16	289	1.8	5.8				
9-28	231	9.0	5.5	9-25	419	2.2	4.2	9-23	292	1.8	3.9	9-23	739	3.6	5.0				
												9-30	998	14.0	3.2				

Oconto River Station at Highway 41 Bridge in Oconto.
Flow data from U.S.G.S. gaging station near Gillett, Wisconsin.

Source: Oconto River - Highway 41 Bridge At Oconto

Year: 1961-62

Date	LABORATORY ANALYSIS																	FIELD DATA		
	Alkalinity Phth. (CaCO$_3$)	Alkalinity Total (CaCO$_3$)	Bacteriological (M.P.N.) per 0.1 ml.	B.O.D. (5-Day)	Chlorides	Color	Hardness (Total)	Nitrogen: Total Organic	Free Ammonia	Nitrates	pH	Phosphorus (Total)	Phosphorus (Sol.)	Solids: Total	Volatile	Solids: Suspended	Volatile	D.O.	pH	Temperature (°C.)
1961																				
4-27	0	95	<.004	4.6	1.0	100	114				7.2			224	82	12	4	7.5	7.2	11
5-23	0	90	<.004	1.8	0.0	120	118				6.8			182	90	6	1	4.9	7.2	17
6-27	0	118	2.1	1.9	3.0	70	134				7.75			194	102	5	4	3.2	7.3	22
7-27	0	130	.93	2.6	0.0	55	151	0.98	0.23	<.12	7.7	.18	0.055	208	96	2	1	2.0	7.4	21.5
8-22	0	124	15	2.0	8.5	40	152				7.2			220	108	2	1	1.8	7.0	21.5
9-20	0	131	2.4	2.8	7.5	70	152				7.7			214	110	2	2	3.8	7.4	19.5
10-24	0	130	43	28.2	6.5	200	152	1.14	2.17	.48	7.1	.10	.02	302	176	11	11	0.5	6.8	9
11-28	0	131	3.9	14	7.0	90	156				7.3			252	136	8	6	7.4	7.8	1
12-21	0	141	24	18	6.5	100	164				7.3			266	158	6	2	4.1	7.2	1
1962																				
1-31	0	147	9.3	23.8	7.0	60	172	.98	2.50	.40	6.9	.12	<.01	288	158	8	8	.1	7.1	1
3-7	0	148	4.3	9.8	9.5	55	172				7.1			270	136	8	1	2.1	7.0	1
3-28	0	142	15	19.6		80	190				7.2			300	142	31	13	7.8	7.2	2
4-25	0	94	24	8.9	1.0	90	110	.95	.74	.13	7.4	.14	.02	186	76	12	12	5.7	7.2	12
5-28	0	116	2.4	3.3	2.5	100	128				7.4			198	90	11	6	2.3	7.2	16
7-2	0	124	2.4	3.4	4.5	100	144				7.3			234	78	9	9	2.5	7.2	21
7-24	0	126	9.3	4.5	7.0	70	154	0.79	0.63	.15	7.40	.24	0.09	196	62	7	2	1.4	7.2	21
9-4	0	124	4.3	3.0	6.0	85	150				7.05			214	88	2	2	1.1	7.2	20
9-25	0	108	2.1	2.4	5.5	80	148				7.00			254	92	5	5	4.3	7.2	13
10-31		121	2.4	>19.4	6.0	140	160	1.93	3.26	<.62	7.1	.08	.04	358	218	6	4	0.6	7.2	5
11-27		126	9.3	86.4	3.0	225	76				6.55			532	372	14	12	0.9	6.8	1.5
12-19		140	9.3	40.8	6.5	100	164				7.30			318	184	30	20	1.9	7.2	0.5
Mean		124		14.2	5		146	1.12	1.58	.31		.14	.04					3.1		
Max.	0	148	43	86.4	9.5	225	190	1.93	3.26	<.62	7.75	.24	.09	532	372	31	20	7.8	7.8	22
Min.	0	90	<.004	1.8	0	40	76	.79	.23	<.12	6.55	.08	<.01	182	62	2	1	.1	6.3	.5

Concentrations expressed as mg/l unless otherwise indicated.

Source: Oconto River - Highway 41 Bridge at Oconto

Year: 1963-64

	LABORATORY ANALYSIS																		FIELD DATA		
Date	Alkalinity Phth. ($CaCO_3$)	Alkalinity Total ($CaCO_3$)	Bacteriological per 0.1 ml.	B.O.D. (5-Day)	Chlorides	Color	Hardness (Total)	Nitrogen: Total Organic	Free Ammonia	Nitrates	pH (s.u.)	Phosphorus (Total)	Phosphorus (Sol.)	Solids: Total	Volatile	Solids: Suspended	Volatile	ABS	D.O.	pH (s.u.)	Temperature °C.
1963																					
1-29		151	43	31	3.5	80	176	1.69	2.70	<.80	7.1	.28		330	170	14	12	.18	.2	7.0	0
2-27		148	1100	25	7	95	172				7.2			294	146	7	5	.26	.2	7.0	1
3-28		79	24	11.2	3.5	90	104				7.35			218	108	20	11	.14	9.6	7.2	0
4-25		120	7.5	3.6	3	75	146	1.15	.36	.52	7.5	.16	.03	206	104	9	8	.09	4.6	7.4	9
5-23		108	9.3	3.6	6	110	120				8.3			196	106	7	2	.14	3.2	7.2	11
6-25		116	9.3	3.7	6	75	144				7.5			200	112	6	6	<.03	2.2	7.2	22
7-30		137	75	3.6	8	90	160	1.50	.98	.12	7.45	.26	.18	244	128	5	3	.14	.5	7.3	24
8-28		138	110	3.0	13	120	162				7.9			250	152	8	8	.10	.5	7.4	20
10-2		122	460	12.2	7	100	156				7.15			268	146	9	9	.11	0	7.2	15½
10-14		122		79.2	7	280	164				6.75			426	288	12	12	.05	0	6.5	16
10-28		136	23	9.1	13	140	164	1.16	1.30	<.36	7.25	.22	.07	246	148	4	4	.08	.2	7.2	11½
11-26		140	7.5	10	8	110	166				7.4			258	130	3	3	.10	2.7	7.1	4
12-16		120	2.1	>94	10	240	168				6.8			504	358	8	8	<.03	2.2	6.5	0
1964																					
1-20		140	.80	23.1	9.5	80	168	1.34	2.19	<.50	7.1	.24	.04	290	156	15	9	.20	.2	7.0	1
2-25		141	1.7	>21	12	110	172				6.85			290	162	11	11	.14	0	7.0	0
3-23		132	2.0	17.8	9.5	90	162				7.0			268	140	4	4	.16	4.0	7.2	4
4-27		100	.80	4.4	4.5	100	138	1.33	.99	.20	6.85	.20	.07	218	110	12	12	.14	2.3	7.1	12
5-18		98	10	4.3	0	120	126				7.2			224	116	6	4	.16	.6	7.0	21
6-22		126	2.7	4.0	8.5	100	154				7.6			234	116	8	7	.12	3.2	7.2	23
7-27		126	16	6.1	11.5	160	150	1.41	1.06	.40	7.3	.40	.31	134	26	7	7	.12	.6	7.2	29
8-17		118	18	8.0	12.5	110	158				7.5			236	140	13	5	.07	3.0	7.2	
9-28		158	5	2.6	7	80	200				7.3			270	116	8	5	<.03	4.4	7.2	13
10-26		124	23	6.6	10	22	156	.98	.84	.10	7.3			246	102	3	3	.06	1.3	7.0	12
11-16		129	15	12.5	6	110	160				7.1			258	126	11	11	.12	.2	7.1	9
12-21		134	7.0	8.3	12.5	100	176				6.9			374	212	12	12	.24	0	6.9	0
Mean		127		>16	8		157	1.32	1.30	<.40		.25	.12					<.12	1.8		
Max.	0	158	1100	>94	13	280	200	1.69	2.70	<.80	8.3	.40	.31	504	358	20	12	.26	9.6	7.4	29
Min.	0	79	.80	2.6	0	22	104	.98	.36	.10	6.75	.16	.03	134	102	3	2	<.03	0	6.5	0

Concentrations expressed as mg/l unless otherwise indicated.

Source : Oconto River-Highway 41 Bridge at Oconto Year: 1965-66

Date	LABORATORY ANALYSIS																		FIELD DATA		
	Alkalinity Phth. ($CaCO_3$)	Alkalinity Total ($CaCO_3$)	Bacteriological per 0.1 ml.	B.O.D. (5-Day)	Chlorides	Color	Hardness	Nitrogen: Total Organic	Free Ammonia	Nitrates	pH (s.u.)	Phosphorus Total	Phosphorus Sol.	Solids: Total	Volat	Solids: Suspended	Volatile	MBAS	D.O.	pH (s.u.)	Temperature °C.
1965																					
1-25	0	152	1.9	>20	12	80	184	1.47	1.77	<.7	7.1	.36	.05	306	156	14	12	.4	0.0	6.9	0
2-2	0	142	4	10.9	9	30	192				7.1			250	118	9	9	.03	0.0	7.0	0
3-22	0	136	2.3	12.2	13	45	176				7.0			270	126	11	8	.15	6.4	7.1	½
4-19	0	62	3	>21.3	3	65	94				6.95			238	146	40	34	.2	8.5	7.1	7
5-24	0	84	30	3.1	2	152	106	1.3	.54	<.2	6.8	.22	.03	204	108	12	5	.11	3.8	7.0	18
6-28	0	123	45	3.4	8	100	140				7.6			222	106	8	7	.14	3.6	7.2	27
7-26	0	125	7	3.0	12	70	160	1.11	.43	.5	8.3	.18	.09	222	110	8	4	.09	3.7	7.3	28
8-23	0	126	18	3.3	12	70	154				7.6			232	110	8	7	.08	2.9	7.3	24
9-20	0	100	32	<.5	4	65	126	.98	.17	.1	7.6	.24	.1	192	78	21	5	.03	5.2	7.2	16
10-25	0	133	4.7	3.2	8	100	170				7.4			250	126	16	3	.04	3.7	7.3	10
11-15	0	133	2.4	7.4	6	70	160				7.0			264	100	8	8	.1	3.7	7.2	3
12-14	0	112	2.3	5.0	3	70	140				7.1			206	94	9	7	.1	9.8	7.2	1
1966																					
1-24	0	151	.3	10.4	10	45	184	1.11	1.24	.64	7.4	.12	.04	268	132	8	6	.1	2.2	7.0	½
2-21	0	128	.8	13.4	7	70	156				6.9			254	132	6	5	.1	6.4	7.0	1
3-28	0	96	1.6	19.1	4	80	120				7.0			230	124	29	17	.12	8.9	7.2	3
4-26	0	96	30	1.3	4	80	120	1.05	.3	<.24	7.3	.04	<.01	188	98	8	6	.1	6.4	7.2	9
5-25	0	112	5.2	3.4	5	90	144				7.0			214	106	8	2	.08	2.4	7.2	20½
6-27	0	110	13	1.3	5	100	140				7.3			220	112	9	5	.04	4.0	7.2	28
7-26	0	101	27	2.4	10	80	144				7.5			224	102	6	6	.06	3.4	7.2	27
8-22	0	120	32	2.1	10	45	152				7.25			214	92	6	5	<.03	2.5	7.2	20½
9-27	0	125	8	2.9	1	70	164				7.15			232	110	7	4	.06	4.0	7.2	16
10-24	0	112	.5	2.6	8	70	168	.85	.49	<.44	7.05	.12	.047	250	84	8	6	<.03	5.3	7.2	8
11-14	0	127	13	36.1	8	140	170				6.5			410	264	19	17	.4	1.9	6.9	3
12-20	0	93	6.2	11.7	13	65	172				6.8			264	138	6	6	.12	3.1	7.1	½
Mean	0	117		8.3	7.4		151	1.12	.71	.4		.18	.053					<.11	4.0		
Max.	0	152	45	36.1	13	152	192	1.47	1.77	.7	8.3	.36	.1	410	264	40	34	.4	9.8	7.3	28
Min.	0	62	.5	.5	1	30	94	.85	.17	.1	6.5	.04	<.01	188	78	6	2	<.03	0.0	6.9	0

Concentrations expressed as mg/l unless otherwise indicated.

Source: Oconto River-Highway 41 Bridge at Oconto

Year: 1967 -68

Date	LABORATORY ANALYSIS																		FIELD DATA		
	Alkalinity Phth. (CaCO$_3$)	Alkalinity Total (CaCO$_3$)	Bacteriological per 0.1 ml.	B.O.D. (5-Day)	Chlorides	Color	Hardness	Nitrogen: Total Organic	Free Ammonia	Nitrates	pH (s.u.)	Phosphorus Total	Phosphorus Sol.	Solids: Total	Volatile	Solids: Suspended	Volatile	MBAS	D.O.	pH (s.u.)	Temperature °C.
1967																					
1-24	0	142	.8	5.7	9	35	176	1.24	.88	.46	7.05	.3	.13	252	96	6	6		.5	7.1	1
2-20	0	142	2.7	6.8	10	43	184				6.9			260	124	4	4		.4	7.0	1
3-20	0	142	2.4	10.2	10	45	180				6.95			258	116	6	5		2.3	7.0	½
4-25	0	68	47	2.6	2	84	92	1.	.28	.48	7.1	.102	.018	158	88	7	5		8.1	7.1	11½
6-12	0	123	340	1.4	3	84	144				7.35			218	102	11	4		5.6	7.4	20
7-27	0	128	80	1.7	8	62	148	.98	.23	.28	7.35	.2	.12	220	106	4	2	.04	6.0	7.5	26
9-13	0	114	14	2.8	7	45	136				6.9			204	88	8	6		6.2	7.2	19
10-18	0	136	7.3	0	7	100	164	.84	1.19	.16	7.4	.12	.05	262	110	3	1	.1	2.9	7.4	10
11-29	0	120	2.9	6.1	7	45	144				7.4			206	90	19	13		6.6	7.4	1
12-18	0	130	2	9	9	50	164				7.3			254	126	9	7		5.0	7.3	1
1968																					
1-29	0	140	2.1	5.3	10	35	168	.85	.50	.28	7.4	.08	.02	238	94	16	6	.06	3.5	7.2	1
2-27	0	146	1.7	4.3	9	25	180				7.2			240	110	3	2		2.2	7.2	1
3-20	0	110	2.5	5.2	5	55	128				7.4			190	86	25	11		7.5	7.2	2
4-15	0	122	23.0	10.6	6	110	160	1.82	1.04	.24	7.5	.14	.022	292	132	26	17		5.0	7.0	9
5-7	0	96	1.4	4.0	8	90	120				7.5			198	82	9	3		5.5	7.4	10
6-25	0	106	17.0	2.5	2	100	128				7.5			194	68	10	3		5.2	7.4	20
7-16	0	112	2.0	3.4	5	80	138	.96	.27	.32	7.8	.12	.028	210	96	5	3	.08	3.5	7.4	28
8-20	0	130	19.0	4.0	9	50	148				7.9			202	94	8	5		5.6	7.2	25
9-17	0	92	3.5	3.7	4	100	116				7.3			216	114	6	4		1.8	7.0	19
10-15	0	128	2.1	1.2	8	45	154	.68	.22	.24	7.7	.07	<.02	206	76	2	0	<.04	4.4	7.6	19
12-2	0	122	4.2	10.1	7	60	156				8.3			238	106	5	3		7.1	7.2	3
12-17	0	144	1.5	8.2	8	55	172				8.2			242	100	6	5		7.6	7.4	1
Mean		123		4.9	6.8		141	1.05	.58	.31		.13	.05						4.7		
Max.		146	340.0	10.6	10	110	184	1.82	1.19	.48	6.9	.30	.13	292	132	26	17	.10	7.6	7.6	28
Min.		68	0.8	0	2	25	92	.68	.22	.16	8.3	.07	<.018	158	68	2	0	<.04	0.4	7.0	½

Drainage Area = approx. 1,060 sq. miles

Concentrations expressed as mg/l unless otherwise indicated.

DRAINAGE AREA APPROX. 1060 SQ. MILES
SOURCE- OCONTO RIVER AT OCONTO

STORET SECONDARY CODE 1900330

DATE	ALKALINITY TOTAL	FECAL COLIFORM	5 DAY BOD	CHLORIDES	COLOR	HARDNESS	--------NITROGEN-------- TOTAL ORG	AMMONIA	NITRATES	TOTAL PHOSPHORUS	-----SOLIDS----- TOTAL	SUS	VOL SUS	---FIELD DATA--- D O	PH	TEMP CENT
1-28-69	126	700	6.4	6.0	40	154	.74	.78	.24*	.10	220	8	4	7.4	7.2	1
2-25-69	140	320	5.5	7.0	45	168					252	3	3	4.9	7.0	1
3-25-69	94	200	3.1	5.0	50	128	.80	.32	.72	.12	210	16	6	12.1	7.4	1
4-22-69	84	40	6.0	3.5	90	106					176	10	5	7.2	7.4	10
5-27-69	110	10*	1.5	4.0	60	132	.82	.40	.24	.06	190	6	2	5.8	7.5	16
6-18-69	129	120	3.1	5.0	60	152					200	8	4	3.9	7.7	18
7-23-69	116	70	3.4	8.0	90	148	.94	.53	.28	.14	214	8	3	2.1	7.4	23
8-13-69	118		2.0	9.0	50	142					200	5	2	2.7	7.7	25
9-10-69	124	45	3.5	10.5	40	152	.98	.34	.10*	.09	212	9	5	3.4	7.7	17
10-08-69	124	20	2.5	9.0	50	150					204	5	4	3.3	7.3	13
11-18-69	120	90	34.0	8.5		156	1.10	4.40	.40*	.05	332	3	2	5.5	7.2	5
12-16-69	150	120	9.0	8.0	55	152					224	7	4	8.1	7.3	1
* MEAN	120		6.7	7.0	57	145	.90	1.13	.33	.09	220	7	4	5.4	7.4	11
1-14-70	140	5	7.5	9.0	55	168	.84	.80	.32	.09	240	3	2	3.2	7.2	1
2-18-70	124	5	6.5	7.5	40	168					244	7	4	3.7	7.0	1
3-10-70	104	5*	4.0	9.0	40	176	.94	.41	.24	.10	254	7	4	5.1	7.2	1
4-14-70	92	10	24.0	5.0	110	132					206	25	11	5.9	6.7	8
8-06-70	130	45	3.0	13.0	50	132	1.30	.27	.19	.10	244	10	4	3.4	7.7	23
12-09-70	128	35	7.0	9.0	80	166	.86	.10	.48	.05	244	8	2	7.4	7.2	1
* MEAN	120		8.7	8.8	63	157	.99	.40	.31	.09	252	10	5	4.8	7.2	6
3-30-71	144	30	8.5	9.0	70	172					234	3	3	7.5	7.2	1
6-30-71	116	1300	4.5	5.5	50	132	1.07	.28	.38	.10	174	8	3	3.5	7.2	27
9-09-71	132	60	2.8	7.0	45	126	.75	.13	.16	.07	192	7	3	4.0	7.4	22
10-20-71	132	20	2.8	6.0	70	148	.67	.74	.16	.08	226	1	1	3.2	7.2	19
11-15-71	120	40	22.0	5.0	100	148	9.99	3.30		.04	306	7	7	4.3	7.1	7
* MEAN	129		8.1	6.5	67	145	3.12	1.11	.23	.07	226	5	3	4.5	7.2	14
1-12-72	142	5	5.5	8.0	55	156	.70	.56	.16	.05	152	7	5	8.5	7.1	1
2-14-72	140	10	4.5	6.0	35	169					140	11	8	7.8	7.3	1
3-20-72	142	5	4.0	6.0	50	162	.03	.83	.20	.10	218	14	3	8.0	7.6	2
4-17-72	84	10	.3	4.0	50	94	.71	.26	.07	.12	150	15	14	12.6	7.3	8
5-22-72	110	20	3.1	5.0	80	124	.98	.25	.05	.08	184	9	8	3.6	7.4	22
6-21-72	124	15	2.5	5.0	45	143	.78	.18	.23	.11	200	8	6	4.3	7.3	14
7-18-72	140	75	4.6	3.0	25	140	.66	.12	.10	.10	188	19	12	4.1	7.8	22
8-22-72	98	15	1.2	3.0	90	120	.87	.18	.09	.07	176	11	3	5.8	7.2	23
9-19-72	134	5	3.1	7.0	60	172	.95	.19	.16	.04	224	9	2	5.3	7.8	19
10-25-72	145	230	20.0	8.0	55	180	.93	1.86	.19	.08	238	4	1	8.2	7.4	5
11-28-72	134	75	6.1	5.0	55	156	.71	.82	.08	.02	200	8	3	8.3	7.4	0
12-14-72	142	40	7.1	7.0	40	162	.69	.91	.24	.02	228	2	0	8.8	7.4	0
* MEAN	128		5.2	5.4	53	148	.68	.56	.14	.07	193	10	5	8.5	7.3	10
** MEAN	124		6.7	6.7	58	148	1.17	.76	.23	.08	217	8	4	5.5	7.3	10

* ANALYSIS WAS LESS THAN FIGURE SHOWN

Concentrations expressed as mg/l unless otherwise indicated.

DRAINAGE AREA APPROX. 1060 SQ. MILES
SOURCE- OCONTO RIVER AT OCONTO

STORET SECONDARY CODE 1900000

DATE	ALKALINITY	FECAL	5 DAY	CHLORIDES	COLOR	HARDNESS	-------NITROGEN-------			TOTAL	-----SOLIDS-----			---FIELD DATA---		
	TOTAL	COLIFORM	BOD				TOTAL ORG	AMMONIA	NITRATES	PHOSPHORUS	TOTAL	SUS	VOL SUS	D O	PH	TEMP CENT
1973																
1-29	149	15	2.1	7.0	60	172	.29	.46	.20	.02	222	2	2	10.2	7.2	0
2-28	144	5	5.5	7.0	40		.79	.80	.32	.04				9.4	7.2	1
3-26	20	200	25.0	2.0	140	100	.84	1.10	.36	.04	240	3	3	11.8	7.2	6
4-25	88	5	3.7	.0	100	100	.72	.17	.10	.05	180	9	4		7.4	12
5-29	88	760	2.0	1.0	80	104	.79	.10	1.40	.10	170	20	2	9.0	7.3	11
6-25	130	100	3.4	4.0	70	144	.60	.13	.15	.07	192	10	3	5.2	7.2	20
7-30	102	140	2.5	5.0	40	146	.81	.06	.09	.07	190	10	8		7.4	12
8-31	124	150	3.4	5.0	50	140	1.00	.11	.12	.06	194	9	6	4.4	7.4	24
9-28	130	30	1.6	5.0	35	148	.52	.18	.22	.04	184	6	5	6.3	7.6	16
10-29	140	1700	3.7	5.0	45	152	.84	.04	.06	.05	196	8	6	10.9	7.6	7
11-26	120	30	6.5	6.0	50	146	.70	.07	.15	.03	212	2	2	10.1	7.3	5
12-26	140	10	4.0	5.0	40	160	.66	.59	.15	.04	210	5	5	13.8	7.9	0
MEAN	115		5.3	4.3	63	137	.71	.32	.28	.05	199	8	4	9.1	7.4	10
MAX	149	1700	25.0	7.0	140	172	1.00	1.10	1.40	.10	240	20	8	13.8	7.9	24
MIN	20	5	1.6	.0	35	100	.29	.04	.06	.02	170	2	2	4.4	7.2	0

Concentrations expressed as mg/l unless otherwise indicated.

OCONTO RIVER FLOW DATA CORRESPONDING TO DATES OF SURFACE WATER QUALITY SURVEYS 1961-1973*

1961	
DATE	FLOW CFS
4-27	1,150
5-23	915
6-27	597
7-27	504
8-22	394
9-20	354
10-24	472
11-28	508
12-21	520

1962	
DATE	FLOW CFS
1-31	310
3-7	350
3-28	760
4-25	1,310
5-28	662
7-2	490
7-24	577
9-4	562
9-25	490
10-31	436
11-27	450
12-19	360

1963	
DATE	FLOW CFS
1-29	310
2-27	290
3-28	900
4-25	718
5-23	642
6-25	342
7-30	205
8-28	219
10-2	350
10-14	275
10-28	338
11-26	419
12-16	260

1964	
DATE	FLOW CFS
1-20	225
2-25	220
3-23	301
4-27	622
5-18	976
6-22	314
7-27	310
8-17	210
9-28	791
10-26	314
11-16	547
12-21	240

1965	
DATE	FLOW CFS
1-25	220
2-2	220
3-22	280
4-19	1,660
5-24	1,390
6-28	375
7-26	292
8-23	240
9-20	978
10-25	490
11-15	743
12-14	1,130

1966	
DATE	FLOW CFS
1-24	385
2-21	440
3-28	967
4-26	1,070
5-25	732
6-27	443
7-26	288
8-22	389
9-27	231
10-24	346
11-14	311
12-20	325

1967	
DATE	FLOW CFS
1-24	385
2-20	305
3-20	320
4-25	1,420
6-12	955
7-27	443
9-13	297
10-18	433
11-29	350
12-18	430

1968	
DATE	FLOW CFS
1-29	380
2-27	265
3-20	720
4-15	1,040
5-7	844
6-25	1,070
7-16	559
8-20	415
9-17	639
10-15	458
12-2	457
12-17	600

1969	
DATE	FLOW CFS
1-28	640
2-25	470
3-25	1,100
4-22	1,190
5-27	651
6-18	567
7-23	429
8-13	411
9-10	325
10-8	401
11-18	505
12-16	520

1970	
DATE	FLOW CFS
1-14	370
2-18	540
3-10	460
4-14	722
8-6	567
12-9	1,000

1971	
DATE	FLOW CFS
3-30	600
6-30	428
9-9	344
10-20	510
11-15	556

1972	
DATE	FLOW CFS
1-12	300
2-14	330
3-20	560
4-17	2,310
5-22	677
6-21	423
7-18	448
8-22	933
9-19	373
10-25	809
11-28	480
12-14	470

1973	
DATE	FLOW CFS
1-29	620
2-28	450
3-26	1,400
4-25	1,810
5-29	3,100
6-25	907
7-30	531
8-31	456
9-28	583
10-29	795
11-26	866
12-26	1,770**

*FLOW DATA FROM U.S.G.S. GAGING STATION NEAR GILLETT, WISC.

**ICE AFFECTED-MAY BE HIGH

PESHTIGO RIVER

SUMMARY OF RESULTS OF COOPERATIVE STREAM SURVEYS
June - September

Stations	Discharge c.f.s. Maximum			Minimum			Miles	Dissolved Oxygen p.p.m. Maximum			Minimum			5 Day B.O.D. p.p.m. Maximum			Temperature Range °C		
	1950	1951	1952	1950	1951	1952		1950	1951	1952	1950	1951	1952	1950	1951	1952	1950	1951	1952
City Bridge	614	1620	1660	7	7	7	0.0	8.0	9.8	7.7	5.0	5.7	5.8	8.4	9.2	7.7	15-26	12-25	18-27.5
One Mile Below							1.0	8.2	9.1	7.9	5.0	6.1	5.6	10.4	12.3	14.1	15-26	12-24	18-27
One Mile from Bay							7.0	6.9	6.3	5.4	0.7	1.4	1.4	18.2	23.2	17.2	15-26	11-25	17-25

Stations	Discharge c.f.s. Maximum			Minimum			Miles	Dissolved Oxygen p.p.m. Maximum			Minimum			5-Day B.O.D. p.p.m. Maximum			Temperature Range °C		
	1953	1954	1955	1953	1954	1955		1953	1954	1955	1953	1954	1955	1953	1954	1955	1953	1954	1955
City Bridge	1569	1610	1510	7	7	120	0.0	8.8	8.8	9.1	6.7	5.6	5.6	12.7	14.5	22.6	14-29	12-25	[illegible].0-27.
One Mile Below							1.0	4.1	5.8	9.5	4.1	5.8	5.2	15.1	16.6	23.3	14-29	11-25	[illegible].0-27.
One Mile from Bay							7.0	0.1	0.0	7.0	0.1	0.0	0.2	16.7	17.5	20.6	14-29	12-25	15.0-27.

1956 Date	Flow cfs	BOD$_5$ mg/l	D.O. mg/l	1957 Date	Flow cfs	BOD$_5$ mg/l	D.O. mg/l	1958 Date	Flow cfs	BOD$_5$ mg/l	D.O. mg/l	1959 Date	Flow cfs	BOD$_5$ mg/l	D.O. mg/l	1960 Date	Flow cfs	BOD$_5$ mg/l	D.O. mg/l
6-6	390	14.9	5.1	6-5	648	11.2	4.6	6-4	728	11.6	4.3	6-3	961	11.8	4.9	6-1	1,860	4.4	4.5
6-13	559	5.0	1.8	6-12	580	11.5	4.0	6-11	596	9.2	4.8	6-10	495	-	6.5	6-8	1,510	8.3	7.0
6-20	970	5.2	3.5	6-19	795	14.2	2.9	6-18	577	11.7	3.9	6-17	371	13.1	3.7	6-17	1,370	39.9	7.6
6-27	1,620	6.8	5.1	6-26	500	23.0	2.8	6-25	637	9.1	3.5	6-24	372	11.8	1.6	6-22	1,450	9.0	5.5
7-5	827	9.0	4.4	7-3	440	3.7	4.2	7-2	1,050	2.7	3.8	7-1	545	14.5	1.1	6-30	1,890	5.3	5.4
7-11	1,180	11.0	4.7	7-10	815	10.4	3.1	7-9	2,100	12.4	6.9	7-8	460	13.8	2.0	7-6	1,090	7.3	6.3
7-18	645	16.2	3.7	7-17	266	13.1	2.1	7-16	624	4.8	4.3	7-15	554	15.7	3.3	7-13	729	7.5	3.2
7-25	1,540	5.7	4.2	7-24	287	15.2	0.4	7-23	510	4.0	3.2	7-22	655	6.3	1.4	7-20	830	12.1	3.6
8-1	684	7.5	2.6	7-31	292	12.6	1.9	7-30	415	7.4	1.5	7-29	322	14.6	0.6	7-27	1,420	7.2	3.6
8-8	1,700	4.1	4.4	8-7	290	14.0	1.0	8-6	283	5.2	0.5	8-5	229	5.2	1.2	8-3	942	9.9	2.4
8-15	720	5.2	3.2	8-14	254	12.0	0.5	8-13	524	6.9	1.1	8-12	634	16.8	2.0	8-10	1,700	5.6	5.0
8-22	587	10.9	1.7	8-21	329	16.0	1.1	8-20	280	5.8	1.0	8-19	796	14.6	4.5	8-17	907	2.2	3.2
8-30	634	14.4	2.0	8-29	496	9.4	0.9	8-28	243	9.2	1.0	8-26	1,300	4.6	1.6	8-24	688	-	2.8
9-6	766	7.8	2.6	9-4	604	3.5	4.0	9-3	414	4.7	3.1	9-3	1,490	10.4	3.2	8-31	1,330	3.5	5.1
9-12	502	16.0	2.8	9-11	452	12.6	2.3	9-10	1,390	13.5	3.0	9-9	843	7.6	1.5	9-7	947	6.3	3.8
9-19	544	8.1	4.9	9-18	852	6.5	2.2	9-17	663	13.2	3.5	9-16	888	3.4	4.0	9-14	773	4.3	3.9
9-26	497	10.2	5.0	9-25	202	5.0	5.2	9-25	507	8.4	1.1	9-23	3,230	6.2	4.1	9-21	878	12.5	4.1
												9-30	2,570	6.7	3.4	9-28	1,450	7.8	5.1

Peshtigo River Station located one mile upstream from Green Bay.
Flow data from U.S.G.S. gaging station at Peshtigo, Wisconsin.

Source: Peshtigo River - Highway 41 Bridge at Peshtigo

Year: 1961-62

Date	LABORATORY ANALYSIS																	FIELD DATA		
	Alkalinity Phth. ($CaCO_3$)	Alkalinity Total ($CaCO_3$)	Bacteriological (M.P.N.) per 0.1 ml.	B.O.D. (5-Day)	Chlorides	Color	Hardness (Total)	Nitrogen: Total Organic	Free Ammonia	Nitrates	pH	Phosphorus (Total)	Phosphorus (Sol.)	Solids: Total	Volatile	Solids: Suspended	Volatile	D.O.	pH	Temperature (°C.)
1961																				
4-27	0	28	<.004	1.5	0	70	99				7.2			146	62	10	3	10.7	7.2	10.5
5-23	0	88	<.004	2.2	0.0	100	96				7.0			192	76	11	3	8.25	7.3	16.5
6-27	0	89	>140	1.1	0.0	60	104				7.95			144	70	5	2	7.5	7.5	20.5
7-27	0	118	.91	1.4	0.0	50	118	0.50	0.01	.08	7.7	.04	0.01	156	70	1	1	7.2	7.5	22.5
8-22	0	108	110	2.5	0.0	40	114				7.4			150	64	4	2	6.8	7.3	23
9-20	0	111	46	0.9	0.0	50	120				8.0			160	74	4	4	8.2	7.6	19
10-24	0	115	.430	0.9	0.0	50	120	.40	.20	.13	7.8	.06	.02	158	74	3	3	9.6	7.2	10
11-28	0	112	110	1.4	0.0	55	122				7.9			166	72	5	4	13.1	7.6	1.5
12-21	0	116	2.4	1.9	0.0	55	128				7.6			160	82	10	8	10.8	7.4	1
1962																				
1-30	0	124	93	5.2	0.0	35	142	.52	.11	.44	7.1	.12	.04	186	74	10	7	10.7	7.3	1
3-7	0	136	43	2.1	0.0	33	146				7.5			188	82	7	5	10.2	7.2	1
3-28	0	126	43	5.6	4.0	45	145				7.5			192	80	5	3	10.2	7.2	2
4-25	0	98	.140	2.2	0.0	60	108	.49	.15	.09	7.7	.12	.02	144	48	7	4	10.0	7.5	12
5-28	0	81	9.3	1.9	0.0	90	90				7.75			134	58	8	5	7.4	7.4	17
7-2	0	99	1.5	2.0	0.0	70	112				7.6			170	60	7	5	6.5	7.4	22
7-24	0	108	24	.5	0.5	35	118	0.41	0.03	0.11	7.75	.10	0.03	132	38	11	11	7.3	7.6	23
9-4	0	96	93	1.6	<0.5	40	116				7.4			144	40	3	3	6.4	7.4	20
9-25	0	88	75	2.0	0.0	60	120				7.30			218	64	5	5	8.2	7.2	13
10-31	0	118	24	1.5	0	65	124	0.44	0.14	0.36	7.85	.04	.02	162	78	2	1	11.0	7.7	6
11-27	0	116	240	2.3	0	55	120				7.10			184	80	5	5	11.7	7.6	1.5
12-19	0	122	240	2.6	0	45	134				8.05			160	70	12	8	11.7	7.4	1
Mean		105		2.1	0		119	.46	.10	.20		.08	.02					9.2		
Max.	0	136	240	5.6	4	100	146	.52	.20	.44	8.05	.12	.04	218	82	12	11	13.1	7.7	23
Min.	0	78	<.004	.5	0	33	90	.40	.01	.08	7.0	.04	.01	132	38	1	1	6.4	7.2	1

Concentrations expressed as mg/1 unless otherwise indicated.

Source: Peshtigo River - Highway 41 Bridge at Peshtigo Year: 1963-64

	LABORATORY ANALYSIS																		FIELD DATA		
Date	Alkalinity Phth. ($CaCO_3$)	Alkalinity Total ($CaCO_3$)	Bacteriological per 0.1 ml.	B.O.D. (5-Day)	Chlorides	Color	Hardness (Total)	Nitrogen: Total Organic	Free Ammonia	Nitrates	pH (s.u.)	Phosphorus(Total)	Phosphorus (Sol.)	Solids: Total	Volatile	Solids: Suspended	Volatile	ABS	D.O.	pH (s.u.)	Temperature °C.
1963																					
1-29		130	240	.6	0	35	140	.38	.12	.28	7.6	.08		196	70	19	5	<.03	11.7	7.4	0
2-27		138	39	2.3	0	25	146				7.6			184	62	1	1	.08	9.6	7.4	0
3-28		95	43	2.3	.5	55	108				7.65			168	68	10	6	.04	11.4	7.4	1
4-25		101	.43	1.6	.5	30	112	.47	.08	.28	8.0	.08	.04	138	44	7	1	<.03	11.0	7.6	9
5-23		98	140	1.3	0	58	104				8.4			150	72	2	0	.06	9.4	7.4	11
6-25		96	43	2.8	0	55	108				7.9			162	94	3	3	.06	7.5	7.6	22
7-30		110	15	2.0	0	38	122	.66	.07	.08	7.75	.06	.02	160	84	6	2	.06	6.0	7.5	25
8-28		106		1.7	0	25	130				7.95			154	76	7	7		6.8	7.5	20
10-2		110	4.3	1.8	0	25	122				7.7			160	60	5	5	<.03	9.0	7.6	16
10-28		126	2.3	2.5	0	30	140	.47	.12	.10	7.2	.08	.03	164	84	3	3	<.03	8.2	7.5	13½
11-26		120	150	1.1	0	30	128				8.2			162	68	1	1	<.03	12.3	7.5	4
12-16		128	2.3	2.0	0	18	146				7.85			184	86	2	2	<.03	13.7	7.6	0
1964																					
1-20		136	.30	3.8	0	25	140	.82	.17	.26	7.9	.12	.04	178	78	4	4	<.03	11.0	7.2	1
2-25		134	.10	3.3	.5	10	140				7.7			162	70	7	7	<.04	12.9	7.4	1
3-23		125	.10	2.1	0	20	132				7.95			162	66	1	1	<.04	13.4	7.8	2
4-27		107	52	3.0	0	30	118	.50	.08	.08	7.65	.08	.02	160	52	5	5	<.04	9.5	7.4	12
5-18		88	40	3.0	0	75	102				7.0			164	80	6	6	.06	7.3	7.4	19
6-22		97	10	1.9	0	55	110				7.5			156	70	7	5	.06	7.4	7.4	23
7-27		98	30	2.1	0	35	112	.67	.08	.18	7.45	.08	.02	150	68	7	7		6.4	7.4	28½
8-17		108	1.0	7.9	0	30	129				7.0			160	72	10	4	<.03	7.9	7.5	
9-28		110	33	2.3	1	40	132				7.3			180	72	2	2	<.03	8.5	7.4	13
10-26		114	2.0	1.4	1	100	134	.52	.05	.17	7.75			162	48	2	2	<.03	11.1	7.4	10
11-16		103	1.0	1.4	0	120	116				7.6			150	58	2	2	<.03	10.3	7.2	8½
12-21		126	<.10	1.0	0	40	156				7.7			186	78	3	3	<.03	12.2	7.4	0
Mean		113		2.3	.1		125	.48	.10	.18		.08	.03					<.04	9.8		
Max.		138	240	7.9	1	120	156	.82	.17	.28	8.4	.12	.04	196	94	19	7	.08	13.7	7.8	28½
Min.		88	<.10	.6	0	10	102	.38	.05	.08	7.0	.06	.02	138	44	1	0	<.03	6.0	7.2	0

Concentrations expressed as mg/l unless otherwise indicated.

Source: Peshtigo River-Highway 41 Bridge at Peshtigo Year: 1965-66

Date	LABORATORY ANALYSIS																		FIELD DATA		
	Alkalinity Phth. ($CaCO_3$)	Alkalinity Total ($CaCO_3$)	Bacteriological per 0.1 ml.	B.O.D. (5-Day)	Chlorides	Color	Hardness	Nitrogen: Total Organic	Free Ammonia	Nitrates	pH (s.u.)	Phosphorus Total	Phosphorus Sol.	Solids: Total	Volatile	Solids: Suspended	Volatile	MBAS	D.O.	pH (s.u.)	Temperature °C.
1965																					
1-25	0	128	<.1	2.7	0	40	146	.45	.15	.44	7.4	.16	.05	182	76	6	4	<.03	10.7	7.2	1
2-2	0	134	<.1	2.1	5	40	148				7.4			176	80	5	5	<.03	10.2	7.2	0
3-22	0	126	.1	1	1	60	148				7.6			172	68	4	3	<.03	11.3	7.2	1
4-19	0	84	.3	1.7	1	130	102				7.1			140	78	11	6	.05	11.3	7.3	7
5-24	0	76	23	2	0	114	92	.93	.17	.2	7.0	.08	.02	160	80	8	4	.04	7.5	7.2	18
6-28	0	92	1.5	2.4	1	66	104				7.8			158	68	12	9	.06	7.7	7.5	25½
7-26	0	98	15	4	0	50	130	.9	.11	.22	7.6	.08	.02	148	70	7	1	<.02	7.2	7.5	27
8-23	0	112	1.9	1.3	1	30	120				7.6			154	68	8	8	<.03	7.4	7.5	23½
9-20	0	108	18	1.7	0	30	124	.49	<.01	.04	7.7	.04	.02	158	66	7	0	<.03	7.5	7.3	16
10-25	0	106	270	3.1	3	70	124				7.6			174	88	10	6	<.03	10.1	7.5	9½
11-15	0	112	4	2	1	60	130				7.25			190	102	8	8	.04	11.5	7.3	3
12-14	0	105	2	1.9	2	55	124				7.4			174	76	2	2	.06	12.1	7.2	2
1966																					
1-24	0	104	<.1	2	0	40	118	.46	.13	.48	7.05	.08	.02	156	78	6	4	<.03	11.3	7.2	½
2-21	0	120	<.1	1.7	0	40	136				7.4			176	74	5	2	.04	16.0	7.2	1
3-28	0	102	2	1.6	1	40	112				7.3			146	62	11	5	<.03	12.7	7.4	3
4-25	0	82	48	2.1	1	55	104	.58	.1	.36	7.4	.04	.01	132	62	2	2	<.03	10.3	7.2	8
5-25	0	88	38	2	1	55	102				7.2			146	70	7	2	<.03	7.6	7.4	19½
6-27	0	94	11	1.8	1	55	90				7.5			162	74	10	5	<.03	7.9	7.5	28½
7-26	0	105	350	3.3	1	35	120	.71	.07	.12	7.65	.06	.03	164	58	6	5	<.03	6.1	7.5	26½
8-22	0	104	13	<.5	1	52	116				7.25			158	66	6	5	<.03	6.3	7.4	20½
9-27	0	114	32	1	0	23	120				7.6			154	64	8	3	<.03	8.5	7.4	15
10-24	0	102	240	2.1	1	35	128	.5	.09	.38	7.1	.068	.018	168	32	8	4	<.03	10.3	7.5	9½
11-14	0	110	350	1	1	25	124				7.25			160	72	7	7	<.03	12.4	7.4	3
12-20	0	110	.9	1.9	1	25	140				7.3			172	76	3	3	<.03	11.8	7.3	½
Mean	0	105		<2.0	1		121	.63	.1	.28		.08	.02					<.03	9.8		
Max.	0	134	350	4.0	5	130	148	.93	.17	.48	7.8	.16	.05	190	102	12	9	.06	16.0	7.5	28½
Min.	0	76	<.1	<.5	0	23	90	.45	<.01	.04	7.0	.04	.01	132	32	2	0	<.03	6.1	7.2	0

Concentrations expressed as mg/l unless otherwise indicated.

Source: Peshtigo River-Highway 41 Bridge at Peshtigo Year: 1967-68

Date	LABORATORY ANALYSIS																		FIELD DATA		
	Alkalinity Phth. (CaCO$_3$)	Alkalinity Total (CaCO$_3$)	Bacteriological per 0.1 ml.	B.O.D. (5-Day)	Chlorides	Color	Hardness	Nitrogen: Total Organic	Free Ammonia	Nitrates	pH (s.u.)	Phosphorus Total	Phosphorus Sol.	Solids: Total	Volatile	Solids: Suspended	Volatile	MBAS	D.O.	pH (s.u.)	Temperature °C.
1967																					
1-24	0	116	1.5	1.4	1	28	144	.35	.17	.36	7.35	.12	.03	176	64	5	3		10.2	7.3	1
2-20	0	118	2.1	1.3	1	25	154				7.3			178	74	3	3		10.3	7.2	1
3-20	0	117	7	1.3	1	20	140				7.45			170	68	6	5		11.4	7.2	½
4-25	0	81	.9	1.2	1	70	104	.6	.12	.44	7.6	.044	.013	156	76	1	1		11.1	7.4	11
6-12	0	95	2.5	<.5	0	60	110				7.30			154	56	3	3		7.3	7.6	19
7-27	0	98	16	1.2	1	78	110	.54	.08	.28	7.4	.076	.022	160	78	4	1	.04	7.1	7.7	25
9-23	0	108	46	.9	0	40	128				7.3			162	68	3	3		8.4	7.8	18
10-18	0	102	45	1.8	0	40	114	.33	.09	.16	7.3	.04	.02	150	50	3	1	<.04	9.4	7.8	11
11-29	0	102	2.7	.6	1	60	116				7.1			166	78	3	1		13.	7.8	1
12-18	0	108	3.5	.9	1	60	126				7.7			166	74	3	3		13.0	7.6	1
1968																					
2-27	0	130	25	<.5	0	23	144				7.6			188	92	2	1		10.3	7.5	1
3-20	0	106	22	6.8	1	30	120				7.8			154	64	7	2		11.6	7.6	2
4-15	0	102	11	2	0	45	124	.65	.12	.2	7.9	.2	.01	176	72	10	6	<.04	10.4	7.4	9
5-7	0	98	1.1	3.1	2	60	112				7.6			170	70	5	1		9.5	7.6	11
6-25	0	90	3.6	.6	0	80	102				7.8			158	62	7	2		7.2	7.6	19½
7-16	0	92	.6	4.6	0	90	108	.50	.08	.32	7.8	.12	.015	164	86	2	2	.06	5.8	7.6	27
8-20	0	102	3	1.5	1	55	112				8.			154	74	5	3		6.8	7.6	24
9-17	0	84	92	<1	1	80	102				7.6			150	62	6	3		7.2	7.5	20
10-15	0	90	11	<1	0	70	112	.72	.12	.32	7.7	.04	.02	160	64	4	2	<.04	7.8	6.6	18
12-2	2	88	1.8	<1	7	45	120				8.4			154	60	3	1		12.4	7.6	2
12-17	0	106	1.5	<1	0	50	116				8.3			156	72	0	0		13	7.6	1
Mean		102		1.6	.9		120	.53	.11	.30		.09	.02						9.7		
Max.	2	130	46	6.8	7	90	154	.72	.17	.44	8.4	.20	.03	188	92	10	6	.06	13.0	7.8	27
Min.	0	81	.6	<.5	0	20	102	.33	.08	.16	7.1	.04	.01	150	50	0	0	<.04	5.8	6.6	½

Drainage Area = approx. 1,124 sq. miles

Concentrations expressed as mg/l unless otherwise indicated.

DRAINAGE AREA APPROX. 1124 SQ. MILES
SOURCE- PESHTIGO RIVER AT PESHTIGO

STORET SECONDARY CODE 1501100

DATE	ALKALINITY TOTAL	FECAL COLIFORM	5 DAY BOD	CHLORIDES	COLOR	HARDNESS	--------NITROGEN-------- TOTAL ORG	AMMONIA	NITRATES	TOTAL PHOSPHORUS	------SOLIDS------ TOTAL	SUS	VOL SUS	---FIELD DATA--- D O	PH	TEMP CENT
1-28-69	118	130	2.1	.0	30	140	.37	.19	.32	.05	180	4	2	10.8	7.0	1
2-25-69	110	160	1.0*	1.0	40	124					162	1	1	11.0	7.3	1
3-25-69	108	50	1.2	1.0	45	130	.52	.15	.24	.05	168	7	3	11.7	7.2	1
4-22-69	70	5*	2.0	.0	70	80					120	6	2	11.3	7.6	8
5-27-69	90	5	1.2	.0	70	104	.50	.06	.16	.08	140	4	2	9.0	7.8	16
6-18-69	100	80	2.5	.0	50	114					140	7	3	8.2	7.9	18
7-23-69	98	2000	2.0	.0	70	112	.57	.12	.16	.07	144	4	1	6.8	7.8	24
8-13-69	118		1.5	1.0	45	120					162	6	2	7.0	7.6	25
9-10-69	110	50	2.5	1.0	30	126	.60	.20	.10*	.06	152	6	3	7.2	7.9	19
10-08-69	114	5*	2.0	.5	25	134					160	5	5	8.7	8.0	13
11-18-69	116	20	1.0	1.0	20	132	.34	.13	.12	.03	170	1*	0	11.9	7.3	4
12-16-69	116	5	1.5	.0	25	134					172	12	7	10.9	7.7	1
# MEAN	106		1.7	.5	43	121	.48	.14	.18	.06	156	5	3	9.5	7.6	11
1-14-70	122	5	1.0*	1.0	25	144	.25	.08	.24	.08	176	1*	0	9.2	7.6	1
2-18-70	116	30	2.0	2.5	20	148					200	4	3	8.8	7.0	1
3-10-70	118	10	1.5	8.5	15	136	.34	.08	.40	.06	180	2	1	9.0	7.1	1
4-14-70	98	10	4.5	2.0	20	128					200	18	6	10.5	7.2	8
8-06-70	120	25	2.5	1.0*	55	128	.68	.07	.19	.08	212	6	2	6.8	7.9	25
12-09-70	98	65	1.5	2.0	80	134	.55	.11	.40	.05	184	7	2	11.1	7.4	1
# MEAN	112		2.2	2.8	36	136	.46	.09	.31	.07	192	6	2	9.2	7.4	6
3-30-71	124	5	3.0	1.5	40	140					168	5	5	11.2	7.2	1
6-30-71	108	5	2.5	.0	50	116	.64	.06	.21	.06	138	10	8	6.8	7.6	27
9-09-71	120	5*	1.5	.0	30	126	.43	.07	.10	.04	150	7	3	6.8	7.9	23
10-20-71	126	5	.6	.0	30	132	.48	.13	.12	.04	174	0	0	8.8	7.8	14
11-15-71	104	5	.3	.0	75	128	.54	.13	.32	.08	172	1	1	12.3	7.8	7
# MEAN	116		1.6	.3	45	128	.52	.10	.19	.06	160	5	3	9.2	7.7	14
1-12-72	128	5	4.3	1.0	55	140	.41	.10	.40	.03	170	6	2	8.5	7.3	1
2-14-72	134	5	1.8	.0	40	148					190	3	2	11.5	7.5	1
3-20-72	118	5	.6	.0	40	130	.36	.07	.28	.04	150	6	0	12.5	7.2	3
4-17-72	96	5	1.2	.0	50	108	.45	.07	.24	.06	140	4	4	13.0	7.5	6
5-22-72	80	10	1.2	.0	80	88	.64	.12	.07	.05	142	6	5	5.1	7.2	22
6-21-72	120	5	.9	.0	50	110	.54	.09	.24	.09	144	6	0	7.3	7.6	19
7-18-72	110	5	1.8	.0	35	110	.47	.08	.12	.04	144	3	3	7.3	7.8	22
8-22-72	116	20	1.0	.0	40	124	.57	.07	.10	.04	162	6	2	7.9	7.6	23
9-19-72	114	5	1.8	6.0	50	128	1.62	.05	.08	.03	176	9	4	9.8	7.8	19
10-25-72	116	40	1.5	.0	100	135	.46	.04	.22	.02	200	3	0	11.6	8.0	5
11-28-72	118	5	.9	.0	80	132	.44	.05	.17	.02	180	1	1	11.3	7.6	1
12-14-72	116	10	3.4	1.0	50	124	.54	.08	.40	.02	170	0	0	10.4	7.3	0
# MEAN	114		1.7	.7	56	123	.59	.07	.21	.04	164	5	2	9.7	7.5	10
## MEAN	111		1.8	.9	47	125	.53	.10	.22	.05	165	5	2	9.5	7.5	10

* ANALYSIS WAS LESS THAN FIGURE SHOWN

Concentrations expressed as mg/l unless otherwise indicated.

DRAINAGE AREA APPROX. 1124 SQ. MILES STORET SECONDARY CODE 1500000
SOURCE- PESHTIGO RIVER AT PESHTIGO

DATE	ALKALINITY TOTAL	FECAL COLIFORM	5 DAY BOD	CHLORIDES	COLOR	HARDNESS	NITROGEN TOTAL ORG	NITROGEN AMMONIA	NITROGEN NITRATES	TOTAL PHOSPHORUS	SOLIDS TOTAL	SOLIDS SUS	SOLIDS VOL SUS	FIELD DATA D O	FIELD DATA PH	FIELD DATA TEMP CENT
1973																
1-10	136	5	4.3	1.0	55	158	.81	.05	.28	.13	200	5	5	11.5	7.2	0
2-13	144	5	1.2	1.0	40	160	.34	.07	.30	.02	198	4	2	10.5	7.3	1
3-21	75		1.5	.0	70	84	.43	.12	.21	.04	120	9	6	13.1	7.2	21
4-16	106	10	1.5	2.0	60	122	.40	.07	.23	.02	180	7	7	10.9	7.5	8
5-09	78	40	1.8	.0	100	92	.56	.07	.07	.03	146	5	0	13.1	7.2	21
6-12	92	40	1.8	.0	110	112	.58	.01	.10	.04	158	10	2	6.1	7.7	22
7-18	106	100	.1	.0	55	110	.95	.05	.04	.03	515	0	2	7.1	8.0	23
8-17	120	10	.6	.0	35		.44	.36	.06	.02	162	9	5	7.7	8.0	27
9-13	112	100	3.7	.0	40	116	.54	.06	.09	.05	202	8	2	8.1	8.2	18
10-10	116	10	1.5	.0	45	120	.68	.12	.16	.03	166	4		7.7	7.7	16
11-16	120	10	1.5	1.0	40	132	.41	.05	.20	.18	174	2	2	13.0	7.9	1
12-26	125	10	1.8	1.0	40	136	.43	.08	.24	.03	168	5	5	14.2	8.3	0
MEAN	111		1.8	.5	58	122	.55	.09	.17	.05	199	6	3	10.3	7.7	13
MAX	144	100	4.3	2.0	110	160	.95	.36	.30	.18	515	10	7	14.2	8.3	27
MIN	75	5	.1	.0	35	84	.34	.01	.04	.02	120	0	0	6.1	7.2	0

Concentrations expressed as mg/l unless otherwise indicated.

PESHTIGO RIVER FLOW DATA CORRESPONDING TO DATES OF SURFACE WATER QUALITY SURVEYS
1961-1973*

1961

DATE	FLOW CFS
4-27	2,250
5-23	1,050
6-27	978
7-27	819
8-22	682
9-20	646
10-24	842
11-28	677
12-21	740

1962

DATE	FLOW CFS
1-30	350
3-7	860
3-28	1,300
4-25	1,150
5-20	923
7-2	530
7-24	690
9-4	1,000
9-25	680
10-31	678
11-27	565
12-19	525

1963

DATE	FLOW CFS
1-29	340
2-27	310
3-28	1,850
4-25	1,020
5-23	1,130
6-25	487
7-30	334
8-28	291
10-2	521
10-28	389
11-26	755
12-16	369

1964

DATE	FLOW CFS
1-20	234
2-25	280
3-23	325
4-27	1,270
5-18	1,380
6-22	337
7-27	328
8-17	269
9-28	1,210
10-26	282
11-16	962
12-21	323

1965

DATE	FLOW CFS
1-25	280
2-2	290
3-22	397
4-19	2,890
5-24	1,930
6-28	429
7-26	307
8-23	179
9-20	1,630
10-25	428
11-15	1,020
12-14	2,150

1966

DATE	FLOW CFS
1-24	500
2-21	440
3-28	1,840
4-26	2,190
5-25	1,520
6-27	311
7-26	328
8-22	349
9-27	247
10-24	348
11-14	333
12-20	418

1967

DATE	FLOW CFS
1-24	360
2-20	315
3-20	562
4-25	2,350
6-12	1,890
7-27	615
9-23	656
10-18	665
11-29	430
12-18	480

1968

DATE	FLOW CFS
2-27	340
3-20	1,420
4-15	2,260
5-7	1,130
6-25	1,940
7-16	1,010
8-20	1,070
9-17	1,220
10-15	942
12-2	775
12-17	737

1969

DATE	FLOW CFS
1-28	940
2-25	749
3-25	2,160
4-22	1,960
5-27	903
6-18	950
7-23	541
8-13	515
9-10	418
10-8	745
11-18	780
12-16	560

1970

DATE	FLOW CFS
1-14	430
2-18	400
3-10	580
4-14	1,170
8-6	467
12-9	1,240

1971

DATE	FLOW CFS
3-30	1,170
6-30	518
9-9	444
10-20	706
11-15	760

1972

DATE	FLOW CFS
1-12	580
2-14	370
3-20	840
4-17	5,100
5-22	898
6-21	609
7-18	623
8-22	1,120
9-19	534
10-25	1,560
11-28	760
12-14	720

1973

DATE	FLOW CFS
1-10	660
2-13	540
3-21	3,570
4-16	3,800
5-9	5,790
6-12	1,780
7-18	681
8-17	742
9-13	670
10-10	1,040
11-16	858
12-26	759**

* FLOW DATA FROM U.S.G.S. GAGING STATION AT PESHTIGO, WIS.

** ICE AFFECTED-MAY BE HIGH

MENOMINEE RIVER

SUMMARY OF RESULTS OF COOPERATIVE STREAM SURVEYS
June - September

Stations	Discharge c.f.s.						Miles	Dissolved Oxygen p.p.m.						5 Day B.O.D. p.p.m.			Temperature Range °C		
	Maximum			Minimum				Maximum			Minimum			Maximum					
	1950	1951	1952	1950	1951	1952		1950	1951	1952	1950	1951	1952	1950	1951	1952	1950	1951	1952
No. 1 Niagara	2400	8690	7360	1050	1140	966	0.0	7.7	9.3	12.2	6.0	5.0	6.7	1.4	1.5	4.8	14-21	12-23	13-22
No. 2 Niagara							1.0	6.8	9.8	11.3	3.7	4.3	5.2	27.7	24.4	24.3	14-21	12-22	13-22
No. 3 Niagara							5.0	7.8	9.5	9.0	5.7	5.1	4.7	17.6	17.8	10.9	14-21	12-22	13-22
Marinette Up. Dam	3820	12800	18900	1280	2780	1580	86.4	7.7	8.6	9.1	5.8	6.2	5.6	3.5	3.1	2.4	16-25	12-25	14-24
Marinette Lower Dam							87.6	7.6	9.0	8.4	6.1	6.6	6.7	5.2	3.2	11.8	16-25	12-25	14-24
Highway '41' Bridge							90.0	7.5	8.9	7.7	5.4	6.4	5.7	5.2	3.8	6.0	16-25	12-25	14-25

Stations	Discharge c.f.s.						Miles	Dissolved Oxygen p.p.m.						5-Day B.O.D. p.p.m.			Temperature Range °C		
	Maximum			Minimum				Maximum			Minimum			Maximum					
	1953	1954	1955	1953	1954	1955		1953	1954	1955	1953	1954	1955	1953	1954	1955	1953	1954	1955
No. 1 Niagara	15300	6690	5170	1100	826	733	0.0	9.0	9.4	9.5	5.8	3.4	4.9	2.3	4.5	5.8	12-24	12-23	14.5-2
No. 2 Niagara							1.0	10.0	9.0	10.2	4.1	2.9	2.4	21.9	27.8	29.8	11-24	12-24	15.0-2
No. 3 Niagara							5.0	9.3	9.6	9.8	6.8	5.7	5.1	8.8	13.8	13.9	11-24	12-24	15.0-2
Marinette Upper Dam	23800	-	7750	1800	-	1280	86.4	8.9	8.3	8.7	6.1	5.9	5.5	3.0	1.8	3.3	15-24	13-26	15.0-2
Marinette Lower Dam							87.6	9.6	9.1	8.4	5.8	4.7	4.5	7.1	14.3	11.5	15-24	13-26	15.0-2
Highway '41' Bridge							90.0	8.3	8.8	8.3	5.4	4.0	3.5	6.9	7.2	6.2	15-24	13-26	15.5-2

1956				1957				1958				1959				1960			
Date	Flow cfs	BOD$_5$ mg/l	D.O. mg/l	Date	Flow cfs	BOD$_5$ mg/l	D.O. mg/l	Date	Flow cfs	BOD$_5$ mg/l	D.O. mg/l	Date	Flow cfs	BOD$_5$ mg/l	D.O. mg/l	Date	Flow cfs	BOD$_5$ mg/l	D.O. mc/l
6-6	2,620	3.6	7.8	6-5	2,360	5.1	7.1	6-4	1,820	4.5	6.8	6-4	3,170	3.7	6.6	6-2	6,340	2.6	8.2
6-13	1,680	3.4	6.0	6-12	2,250	3.7	6.6	6-11	2,320	3.6	6.4	6-11	2,260	2.5	5.6	6-9	5,770	2.6	8.0
6-20	4,750	5.0	7.3	6-19	2,810	4.2	6.0	6-18	2,080	5.0	6.1	6-18	1,800	5.3	6.0	6-16	3,080	3.6	7.4
6-27	3,190	2.6	6.8	6-26	1,800	3.7	5.4	6-25	2,180	8.4	5.8	6-25	1,490	4.6	4.6	6-23	4,350	2.9	8.2
7-5	4,310	-	7.4	7-3	1,590	3.2	5.4	7-3	10,700	3.9	6.8	7-2	1,970	3.3	5.3	6-30	4,300	2.6	7.0
7-11	6,760	3.6	6.6	7-10	1,440	4.3	5.0	7-9	6,650	0.5	7.4	7-9	1,840	3.6	5.4	7-7	2,530	3.0	7.4
7-18	4,030	3.1	6.8	7-17	1,200	4.1	4.2	7-17	3,860	2.6	6.0	7-16	1,430	5.5	5.4	7-14	1,970	2.6	5.5
7-25	3,760	3.8	6.4	7-24	1,590	6.2	5.0	7-23	2,210	3.0	6.1	7-23	1,550	4.9	4.8	7-21	2,180	5.3	5.4
8-1	2,530	1.6	5.7	7-31	1,500	9.9	3.5	7-30	2,490	4.9	5.4	7-30	1,190	3.4	4.0	7-28	4,160	4.4	6.2
8-8	4,270	4.6	6.6	8-7	1,060	7.2	5.3	8-6	1,720	4.5	5.9	8-6	1,430	4.2	4.4	8-4	2,500	2.1	5.7
8-15	2,180	3.1	5.9	8-14	1,250	6.2	4.4	8-13	1,940	5.7	5.2	8-13	1,900	3.8	5.0	8-11	2,300	3.5	6.6
8-22	2,370	6.5	6.2	8-21	1,200	5.2	4.6	8-20	1,580	6.0	5.5	8-27	4,710	3.0	5.7	8-18	2,180	4.3	5.9
8-29	2,380	3.9	5.8	8-30	1,440	5.8	5.1	8-29	1,370	7.4	5.9	9-3	3,960	6.3	6.5	8-25	1,940	3.6	5.5
9-5	1,850	1.0	6.4	9-4	2,220	0.9	7.4	9-3	1,540	0.9	7.8	9-10	3,920	3.9	6.5	9-1	5,160	2.4	7.0
9-12	2,390	3.6	6.8	9-12	1,520	5.9	6.4	9-10	2,780	2.9	7.2	9-17	2,950	2.3	8.3	9-8	2,880	3.1	6.0
9-19	1,960	5.0	7.6	9-18	2,120	2.3	7.8	9-18	1,880	3.9	6.7	9-24	8,280	3.0	8.2	9-15	2,320	4.6	8.1
9-26	1,940	5.0	7.1	9-25	1,910	4.6	7.3	9-25	1,940	5.0	6.3					9-22	2,360	5.1	7.4
																9-29	3,120	3.2	7.3

Menominee River Station at Highway 41 Bridge in Marinette.
Flow data from U.S.G.S. gaging station below Koss, Michigan.

Source: Menominee River - Upper Dam at Marinette

Year: 1961-62

Date	LABORATORY ANALYSIS																	FIELD DATA		
	Alkalinity Phth. ($CaCO_3$)	Alkalinity Total ($CaCO_3$)	Bacteriological (M.P.N.) Per 0.1 ml.	B.O.D. (5-Day)	Chlorides	Color	Hardness (Total)	Nitrogen: Total Organic	Free Ammonia	Nitrates	pH	Phosphorus (Total)	Phosphorus (Sol.)	Solids: Total	Volatile	Solids: Suspended	Volatile	D.O.	pH	Temperature (°C.)
1961																				
4-27	0	66	.093	1.9	2.5	65	80				7.3			134	62	9	3	10.7	7.4	8.5
5-23	0	58	1.5	1.9	0.0	80	66				7.5			118	54	6	2	8.8	7.4	14
6-27	0	79	.24	0.1	0.0	70	100				7.9			152	76	8	6	6.9	7.5	20
7-27	0	96	.43	0.2	1.0	50	106	.34	.024	<.02	7.5	.04	.015	156	80	1	1	6.7	7.5	24
8-22	0	92	7.5	2.2	3.0	50	106				7.4			152	66	2	2	7.5	7.3	23.5
9-20	0	197	.93	0.8	2.5	55	118				7.9			170	80	1	1	8.1	7.7	19
10-24	0	108	.290	0.8	1.0	60	126	.68	.22	.32	7.8	.06		176	78	2	2	9.7	7.2	10
11-28	0	95	.430	1.5	1.0	45	114				8.0			160	66	3	3	12.9	7.4	1
12-21	0	97	.430	1.2	2.5	43	120				7.7			172	90	3	3	10.8	7.2	1
1962																				
1-31	0	88	.093	0.8	1.5	28	120	.32	.10	.24	7.1	.06	<.02	160	62	2	2	8.6	7.3	1
3-7	0	101	.230	1.4	3.5	27	124				7.0			202	76	5	1	8.3	6.9	1
3-28	0	94	.930	6.2	1.0	43	120				7.3			168	70	5	4	9.8	7.2	4
4-25	0	80	2.4	1.8	0.0	60	94	.53	.11	.09	7.0	.10	.02	142	48	11	7	10.1	7.5	12
5-28	0	70	2.4	1.7	0.0	75	98				7.7			164	64	6	4	7.4	7.4	17
7-2	0	85	.430	1.7	0.0	65	104				7.15			160	56	7	7	6.8	7.4	22
7-24	0	80	.430	1.1	2.0	45	106	0.38	0.07	0.12	7.55	.07	.02	132	36	7	5	7.2	7.5	23.5
9-4	0	87	7.5	0.9	<0.5	65	128				7.3			158	64	10	4	6.6	7.4	21
9-25	0	90	.091	1.5	0.5	63	116				7.25			184	68	5	5	8.3	7.2	14
10-31	0	85	.430	1.2	2.0	55	120	0.37	0.06	0.32	7.75	.04	.02	166	72	0	0	11.2	7.6	6
11-27	0	96	1.5	0.7	2	40	124				7.00			194	90	4	4	12.1	7.4	1
12-19	0	99	.390	2.4	1.0	40	124				7.60			168	72	0	0	10.4	7.2	1
Mean		93		1.5	1.5		110	.43	.09	.18		.06	.02					9.0		
Max.	0	197	7.5	6.2	3.5	80	128	.68	.22	.32	8.0	.10	.02	202	90	11	7	12.9	7.7	24
Min.	0	58	.091	.1	0	27	66	.32	.02	<.02	7.0	.04	.015	118	36	0	0	6.7	6.9	1

Concentrations expressed as mg/l unless otherwise indicated.

Source: Menominee River - Upper Dam at Marinette

Year: 1963-64

Date	Alkalinity Phth. ($CaCO_3$)	Alkalinity Total ($CaCO_3$)	Bacteriological per 0.1 ml.	B.O.D. (5-Day)	Chlorides	Color	Hardness (Total)	Nitrogen: Total Organic	Free Ammonia	Nitrates	pH (s.u.)	Phosphorus (Total)	Phosphorus (Sol.)	Solids: Total	Volatile	Solids: Suspended	Volatile	ABS	D.O.	pH (s.u.)	Temperature °C.
	LABORATORY ANALYSIS																		FIELD DATA		
1963																					
1-29		88	.072	1.8	2.5	75	136	.30	.08	.40	7.25	.0	.04	198	70	3	2	.04	7.1	7.2	0
2-27		91	.43	2.7	2	55	136				7.1			184	80	0	0	.12	6.9	7.0	1
3-28		88	4.3	2.0	1.5	36	110				7.3			170	62	8	5	.06	8.5	7.2	2
4-25		90	.93	1.5	0	40	118	.87	.09	.32	7.7	.08	.05	146	64	8	7	<.03	10.1	7.5	10
5-23		80	.43	1.0	0	65	96				7.8			142	68	4	4	.06	9.3	7.4	11
6-25		70	.091	2.1	0	75	88				7.85			140	82	1	1	.06	7.1	7.4	23
7-30		89	.091	1.3	1	55	110	.51	.05	.12	7.75	.06	.04	160	82	6	1	.08	6.2	7.4	25
8-28		91	24	1.0	2	40	122				8.25			160	86	5	4		7.0	7.4	20
10-2	2	98	.073	1.2	4	50	124				8.3			188	84	15	10	.06	8.4	7.6	17
10-28		106	.15	2.3	3	35	132	.35	.09	<.20	7.8	.08	.02	172	94	3	3	<.03	7.9	7.5	14
11-26		106	2.3	2.9	3.5	30	132				7.8			182	76	2	1	.06	11.4	7.2	3
12-16		112	.21	3.3	3	25	144				7.8			176	72	4	4	.05	11.7	7.2	½
1964																					
1-20		116		0.8	3	30	132	.34	.14	<.04	7.4	.10	.03	192	86	6	3	.05	7.7	7.0	1
2-25		120	<.10	2.4	3.5	35	140				7.5			184	80	3	3	<.04	7.9	7.1	1
3-23		105	.20	2.7	2.5	35	128				7.3			182	78	3	3	.08	10.7	7.2	1
4-27		86	1.9	1.5	.5	50	108	.50	.11	.08	7.55	.08	.02	152	90	8	6	<.04	9.6	7.4	12
5-18		74	.80	2.6	0	75	96				7.2			168	86	7	7	.07	7.5	7.3	18
6-22		75	.30	3.0	0	55	94				7.5			142	68	6	4	.08	7.8	7.4	23½
7-27		78		1.4	3	35	106	.63	.08	.14	7.3	.06	.01	140	62	7	7	<.03	6.9	7.4	29
8-17		88	.20	3.6	0	80	112				7.7			156	80	7	2	<.03	8.5	7.6	21
9-28		92	2.0	1.7	1	55	124				7.3			194	80	9	3	<.03	8.9	7.4	13½
10-26		85	<1.0	2.0	2.5	25	122	.48	.04	.13	7.45			168	60	6	6		11.4	7.3	11
11-16		94	2.8	<.5	1.5	50	114				7.5			164	58	2	2	<.03	10.4	7.2	8½
12-21		96	.10	2.0	1	30	128				7.6			172	68	6	6	.06	12.3	7.2	½
Mean		92		2.0	1.5		119	.50	.08	<.18		.07	.03					<.05	8.8		
Max.	2	120	24	3.6	4	80	144	.87	.14	.40	8.3	.10	.05	198	94	15	10	.12	12.3	7.6	29
Min.	0	70	<.10	<.5	0	25	88	.30	.04	<.04	7.1	.06	.01	140	58	0	0	<.03	6.2	7.0	0

Concentrations expressed as mg/l unless otherwise indicated.

Source: Menominee River-Upper Dam at Marinette

Year: 1965-66

Date	LABORATORY ANALYSIS																		FIELD DATA		
	Alkalinity Phth. (CaCO$_3$)	Alkalinity Total (CaCO$_3$)	Bacteriological per 0.1 ml.	B.O.D. (5-Day)	Chlorides	Color	Hardness	Nitrogen: Total Organic	Free Ammonia	Nitrates	pH (s.u.)	Phosphorus Total	Phosphorus Sol.	Solids: Total	Vola.	Solids: Suspend	Volatile	MBAS	D.O.	pH (s.u.)	Temperature °C.
1965																					
1-25	0	92	.1	2.6	2	40	116	.46	.18	.36	7.1	.22	.06	160	58	2	2	<.03	10.7	7.2	1
2-22	0	90	.3	1.0	2	70	136				7.2			152	68	4	4	.03	9.7	7.2	½
3-22	0	98	.3	.8	3	100	126				7.4			162	62	2	2	.03	10.6	7.2	1
4-19	0	60	.8	2.7	1	200	84				6.9			134	52	27	11	.07	11.7	7.2	2
5-24	0	56	1.3	1.7	0	140	76	.82	.14	<.2	6.9	.08	.04	138	72	11	5	.04	8.0	7.1	18
6-28	0	82	.8	.7	0	55	102				7.75			158	60	16	7	.04	7.9	7.4	26½
7-26	0	92	2.	2.1	2	35	122	.4	.12	.16	7.8	.04	.02	150	64	6	2	.04	7.4	7.6	26
8-23	0	94	.4	1.7	1	25	110				7.6			152	62	6	5	<.03	7.8	7.4	25
9-20	0	94	.7	.6	2	25	111	.46	<.01	.04	7.8	.02	.02	148	60	2	0	<.03	8.4	7.4	17
10-25	0	97	<.1	1.0	1	50	118				7.85			182	86	6	3	<.03	10.5	7.6	9
11-15	0	95	.6		2	40	116				7.3			168	26	7	7	.03	12.1	7.3	3
12-14	0	86	1.3	2.0	1	50	106				7.3			148	58	3	3	.06	12.2	7.2	1
1966																					
1-24	0	84	.1	2.6	1	33	108	.39	.1	.32	7.0	.06	.01	152	70	6	6	.03	10.7	7.2	½
2-21	0	74	.1	1.7	2	35	120				7.3			166	62	2	1	.04	15.1	7.1	1
3-28	0	70	.4	.6	2	45	88				7.0			122	46	11	6	.04	13.3	7.2	2
4-26	0	62	1.3	2.0	1	65	82	.59	.14	.38	7.9	.04	<.01	118	52	5	3	<.03	10.6	7.1	7
5-25	0	70	2.5	1.3	1	55	90				7.0			132	56	6	3	<.03	7.9	7.2	18½
6-27	0	76	9	1.9	1	70	94				7.35			146	68	3	3	.08	6.3	7.2	27½
7-26	0	84	11	2.1	1	30	106				7.7			158	52	4	4	<.03	6.7	7.4	27
8-22	0	82	4	.8	2	35	108				7.25			158	66	6	3	<.03	6.9	7.3	19½
9-27	0	84	1.8	1.3	1	35	104				7.2			144	58	6	3	.04	9.0	7.4	15½
10-24	0	78	5.9	1.2	2	47	116				7.1			168	40	8	6	<.03	10.8	7.3	8½
11-14	0	76	1.6	1.5	2	55	98				7.15			170	72	10	8	<.03	12.4	7.2	3
12-20	0	84	1.6	.8	2	35	120				7.25			152	62	2	2	<.03	12.2	7.2	½
Mean	0	82		1.4	1.5		106	.52	.12	.24		.08	.03					<.04	10.0		
Max.	0	98	11	2.7	3	200	136	.82	.18	.38	7.9	.22	.06	182	86	27	11	.08	15.1	7.6	27½
Min.	0	56	<.1	.6	0	25	76	.39	.01	.04	6.9	.02	<.01	118	26	2	0	<.03	6.3	7.1	½

Concentrations expressed as mg/l unless otherwise indicated.

Source : Menominee River-Upper Dam at Marinette Year: 1967-68

Date	LABORATORY ANALYSIS																		FIELD DATA		
	Alkalinity Phth. (CaCO$_3$)	Alkalinity Total (CaCO$_3$)	Bacteriological per 0.1 ml.	B.O.D. (5-Day)	Chlorides	Color	Hardness	Nitrogen: Total Organic	Free Ammonia	Nitrates	pH (s.u.)	Phosphorus Total	Phosphorus Sol.	Solids: Total	Volatile	Solids: Suspended	Volatile	MBAS	D.O.	pH (s.u.)	Temperature °C.
1967																					
1-24	0	83	1.0	2.3	2	37	108	.34	.13	.28	7.3	.14	.03	152	52	6	5		10.6	7.0	1
2-20	0	82	1.9	.6	2	35	116				7.0			146	58	2	2		10.2	7.0	1
3-20	0	92	2.1	<.5	3	25	120				7.1			156	62	5	5		10.5	7.0	½
4-25	0	36	1.4	.6	1	70	64	.56	.12	.4	7.35	.048	.011	138	64	4	2		10.8	7.2	9
6-12	0	83	3.8	.5	1	56	102				7.25			142	66	4	3		7.4	7.4	19
7-27	0	84	6	1.4	0	52	96	.42	.01	.18	8.05	.12	.019	140	66	4	1	.04	7.6	7.3	27
9-13	0	86	1.6	2.2	0	35	108				6.6			150	62	3	2		8.4	7.8	19
10-18	0	92	2.3	3.7	1	40	108	.3	.09	.08	7.8	.04	.02	142	36	8	5	<.04	10.3	7.8	10
11-29	0	80	.2	.9	1	55	96				7.1			142	64	5	2		13.9	7.7	½
12-18	0	84	.3	.6	1	45	108				7.3			144	56	6	4		12.8	7.6	1
1968																					
1-29	0	92	.1	.9	2	35	116	.34	.09	.24	7.7	.06	<.02	150	38	1	1	<.04	10.5	7.4	1
2-27	0	96	.47	<.5	2	30	114				7.6			156	60	2	1		11.5	7.5	1½
3-20	0	90	.7	1.1	2	33	108				7.7			144	42	6	1		11.1	7.6	1
4-15	0	78	.6	1.7	0	50	100	.50	.16	.20	7.7	.07	.014	148	58	5	5	<.04	10.5	7.4	9
5-7	0	66	.42	3.1	5	60	92				7.6			148	60	6	2		9.7	7.6	11
6-25	0	78	3.5	0.6	0	80	94				7.5			146	74	7	2		7.6	7.5	19
7-16	0	74	.9	<1.0	0	100	94	.49	.08	.28	7.5	.14	.013	146	72	6	3	.06	6.4	7.5	27
8-20	0	86	3.3	4.6	1	55	100				8.0			140	64	3	2		7.7	7.8	24
9-17	0	68	2.2	<1.0	1	90	88				7.2			146	70	8	3		7.8	7.2	19
10-15	0	80	.54	<1.0	1	50	106	.47	.29	.24	7.7	.04	<.02	148	68	3	1	<.04	8.8	7.4	17
12-2	0	81	.16	<1.0	1	40	104				8.1			136	50	2	1		13.0	7.4	2
12-17	0	92	.28	2.4	0	45	116				7.8			148	64	2	0		13.1	7.6	1
Mean		81		1.3	1.2		103	.43	.12	.24		.08	.02						10.0		
Max.		96	6.0	4.6	5	100	120	.56	.29	.40	8.1	.14	.03	156	74	7	5	.06	13.9	7.8	27
Min.		36	0.1	<0.5	0	25	64	.30	.01	.08	6.6	.04	.011	136	36	1	0	<.04	6.4	7.0	½

Drainage Area = approx. 4,150 sq. miles

Concentrations expressed as mg/l unless otherwise indicated.

DRAINAGE AREA APPROX. 4150 SQ. MILES
SOURCE- MENOMINEE RIVER AT MARINETTE

STORET SECONDARY CODE 1400370

DATE	ALKALINITY	FECAL	5 DAY	CHLORIDES	COLOR	HARDNESS	--------NITROGEN-------			TOTAL	-----SOLIDS-----			---FIELD DATA---		
	TOTAL	COLIFORM	BOD				TOTAL ORG	AMMONIA	NITRATES	PHOSPHORUS	TOTAL	SUS	VOL SUS	D O	PH	TEMP CENT
1-28-69	88	10*	1.5	1.0	40	108	.39	.21	.24*	.04	146	3	1	11.0	7.2	1
2-25-69	90	30	1.0*	4.0	45	108					148	1*	0	11.4	7.3	1
3-25-69	88	40	1.0*	2.0	45	112	.38	.05	.32	.04	156	5	1	11.6	7.6	1
4-22-69	58	5	2.0	.0	70	72					114	8	3	11.1	7.6	9
5-27-69	70	55	2.5	.0	110	86	.40	.11	.16	.04	100	4	1	9.5	7.7	17
6-18-69	86	5	1.0*	.0	50	102					130	6	2	8.6	7.8	17
7-23-69	93	5	1.2	1.0	32	102	.39	.07	.16	.07	138	4	1	7.5	7.7	25
8-13-69	98		1.0*	1.0	30	120					150	2	1	7.3	7.9	26
9-10-69	95	5*	2.0	2.0	20	116	.42	.14	.10*	.06	142	4	2	8.1	8.1	19
10-08-69	96	5	1.0*	1.5	20	122					148	4	3	9.4	8.1	13
11-18-69	90	15	1.0	1.0	30	112	.28	.08	.16	.02	152	1*	0	12.2	7.5	5
12-16-69	94	10	1.0	2.0	25	112					144	1*	0	10.8	7.2	1
* MEAN	87		1.4	1.3	43	106	.38	.11	.19	.05	139	4	1	9.9	7.6	11
1-14-70	96	15	1.0	1.0	25	116	.20	.07	.16	.04	154	1*	0	9.4	7.3	1
2-18-70	96	5	1.0*	.5	20	120					172	4	2	8.8	7.3	1
3-10-70	102	5*	1.0*	3.0	15	124	.24	.09	.24	.04	160	1*	0	9.2	7.4	1
4-14-70	100	5*	3.0	4.0	20	116					160	6	2	10.9	7.6	6
8-06-70	86	5*	1.5	1.0*	35	98	.36	.04	.11	.04	190	1*	0	8.4	7.9	25
12-09-70	74	80	2.0	2.0	70	108	.33	.11	.28	.02	150	6	2	12.4	7.2	1
* MEAN	92		1.6	1.9	31	114	.28	.08	.20	.04	158	4	1	9.9	7.5	6
3-30-71	94	5	3.0	2.0	40	116					154	4	4	11.9	7.2	2
6-30-71	90	13000	2.5		50	104	.97	.10	.16	.04	128	4	2	7.3	7.5	27
9-09-71	90	700	.9	.0	25	112	.25	.09	.08	.04	152	6	3	7.9	7.9	22
10-20-71	96	10	1.2	.0	80	116	.07	.11	.16	.04	160	2	0	9.6	7.8	19
11-15-71	96	5*	.3	2.0	65	88	.50	.12	.24	.03	162	2	1	11.8	7.8	7
* MEAN	93		1.6	1.0	52	107	.45	.11	.16	.04	155	4	2	9.6	7.6	14
1-12-72	98	5	4.6	1.0	45	118	.35	.08	.16	.02	122	4	3	11.0	7.4	1
2-14-72	104	5	.9	.0	30	132					146	1	0	10.3	7.3	1
3-20-72	86	5	1.2	1.0	30	124	.34	.07	.20	.03	142	3	0	12.5	7.4	2
4-17-72	92	15	.9	.0	35	82	.39	.09	.16	.04	134	4	3	13.5	7.5	3
5-22-72	68	10	1.5	.0	70	80	.64	.05	.06	.04	126	7	5	6.5	7.5	22
6-21-72	88	5	1.2	.0	40	96	.38	.07	.19	.05	140	2	0	7.8	7.9	18
7-18-72	94	5	1.8	.0	30	102	.46	.07	.12	.04	134	2	2	7.0	7.9	22
8-22-72	86	10	1.0	.0	45	100	.35	.06	.08	.03	164	12	4	5.6	7.6	22
9-19-72	58	15	2.5	.0	60	84	.40	.05	.12	.03	168	7	3	9.8	8.0	19
10-25-72	84	5	1.5	.0	100	104	.41	.05	.24	.02	160	5	1	11.3	7.4	4
11 28-72	82	5	1.2	.0	70	96	.37	.05	.06	.07	132	0	0	11.8	7.3	1
12 14-72	86	10	2.8	2.0	55	98	.38	.06	.28	.02	140	0	0	11.7	7.2	0
* MEAN	86		1.8	.3	51	101	.41	.06	.15	.04	143	4	2	9.9	7.5	10
** MEAN	88		1.6	1.0	45	106	.39	.08	.17	.04	145	4	1	9.8	7.6	10

* ANALYSIS WAS LESS THAN FIGURE SHOWN

Concentrations expressed as mg/l unless otherwise indicated.

DRAINAGE AREA APPROX. 4150 SQ. MILES
SOURCE- MENOMINEE RIVER AT MARINETTE

STORET SECONDARY CODE 1600000

DATE	ALKALINITY	FECAL	5 DAY	CHLORIDES	COLOR	HARDNESS	-------NITROGEN-------			TOTAL	-----SOLIDS-----			---FIELD DATA---		
	TOTAL	COLIFORM	BOD				TOTAL ORG	AMMONIA	NITRATES	PHOSPHORUS	TOTAL	SUS	VOL SUS	D O	PH	TEMP CENT
1973																
1-03	94	5	.9	.0	50	110	.25	.10	.13	.04	152	1	1	10.2	7.2	0
2-06	101	5	2.5	.0	50	116	.13	.08	.22	.02	146	1	0	10.9	7.2	0
3-09	91	55		6.0	50	106	.39	.07	.22	.24	136	2		11.2	7.1	1
4-04	64	112	1.5	.0	70	80	.31	.02	.19	.03	112	1		13.1	7.4	3
5-08	48	20	1.8	.0	100	68	.48	.06	.09	.03	116	9		9.8	7.2	10
6-11	92	40	1.2	.0	70	104	.49	.02	.10	.03	150	7		9.6	7.6	22
7-09	100	10	3.7	.0	50	112	.48	.03	.01	.22	158	6		8.1	8.0	25
8-10	100	5	1.0	10.0	40	112	.32	.04	.11	.02	150	3			7.8	21
9-04	94	40	1.0	.0	40	112	.37	.01	.02	.02	154	7		8.2	8.2	25
10-02	108	30	2.1	.0	30	124	.38	.17	.11	.14	160	5		10.2	8.3	16
11-09	102	20	1.2	3.0	40	124	.35	.02	.10	.02	160	4		11.8	8.0	2
12-26	106	10	1.2	1.0	40	122	.35	.12	.15	.02	156	2	2	14.5	7.0	1
MEAN	92		1.6	1.7	53	108	.36	.06	.12	.07	146	4	1	10.7	7.6	11
MAX	108	112	3.7	10.0	100	124	.49	.17	.22	.24	160	9	2	14.5	8.3	25
MIN	48	5	.9	.0	30	68	.13	.04	.01	.02	112	1	0	8.1	7.0	0

Concentrations expressed as mg/l unless otherwise indicated.

MENOMINEE RIVER FLOW DATA CORRESPONDING TO DATES OF SURFACE WATER QUALITY SURVEYS
1961-1973*

1961		1962		1963		1964		1965	
DATE	FLOW CFS	DATE	FLOW CFS	DATE	FLOW CFS	DATE	FLOW CFS	DATE	FLOW CFS
4-27	7,000	1-31	1,880	1-29	1,510	1-20	1,160	1-25	1,440
5-23	5,550	3-7	1,870	2-27	1,510	2-25	1,220	2-22	1,560
6-27	3,250	3-28	2,990	3-28	2,950	3-23	1,620	3-22	1,540
7-27	2,210	4-25	8,020	4-25	2,710	4-27	2,970	4-19	9,570
8-22	1,950	5-28	4,630	5-23	4,770	5-18	5,230	5-24	7,490
9-20	1,620	7-2	2,320	6-25	2,800	6-22	1,980	6-28	1,870
10-24	1,660	7-24	1,870	7-30	1,390	7-27	1,550	7-26	1,420
11-28	1,730	9-4	2,670	8-28	1,490	8-17	1,310	8-23	1,420
12-21	2,390	9-25	2,280	10-2	1,120	9-28	3,400	9-20	2,320
		10-31	1,940	10-28	1,100	10-26	1,750	10-25	2,070
		11-27	1,730	11-26	1,360	11-16	3,470	11-15	2,500
		12-19	1,900	12-16	1,100	12-21	1,840	12-14	3,480

1966		1967		1968		1969		1970	
DATE	FLOW CFS	DATE	FLOW CFS	DATE	FLOW CFS	DATE	FLOW CFS	DATE	FLOW CFS
1-24	2,400	1-24	2,130	1-29	1,470	1-28	3,760	1-14	2,000
2-21	2,120	2-20	2,100	2-27	1,420	2-25	2,930	2-18	1,830
3-28	5,160	3-20	1,510	3-20	3,920	3-25	4,500	3-10	2,310
4-26	7,440	4-25	6,470	4-15	4,910	4-22	6,750	4-14	2,500
5-25	4,940	6-12	3,420	5-7	3,570	5-27	4,070	8-6	1,890
6-27	2,540	7-27	2,500	6-25	6,120	6-18	3,300	12-9	4,700
7-26	1,680	9-13	1,390	7-16	4,050	7-23	2,470		
8-22	2,160	10-18	2,230	8-20	2,870	8-13	2,100		
9-27	1,640	11-29	2,500	9-17	5,600	9-10	1,340		
10-24	2,570	12-18	2,350	10-15	2,640	10-8	2,440		
11-14	2,370			12-2	2,840	11-18	2,300		
12-20	2,380			12-17	3,360	12-16	2,140		

1971		1972		1973	
DATE	FLOW CFS	DATE	FLOW CFS	DATE	FLOW CFS
3-30	3,550	1-12	2,460	1-3	3,360
6-30	2,810	2-14	1,780	2-6	2,620
9-9	1,540	3-20	1,850	3-9	5,130
10-20	2,800	4-17	7,970	4-4	9,010
11-15	2,910	5-22	4,330	5-8	12,000
		6-21	2,750	6-11	4,480
		7-18	2,060	7-9	2,070
		8-22	5,250	8-10	2,460
		9-19	1,920	9-4	2,680
		10-25	5,300	10-2	2,160
		11-28	3,230	11-9	2,210
		12-14	3,000	12-26	2,180

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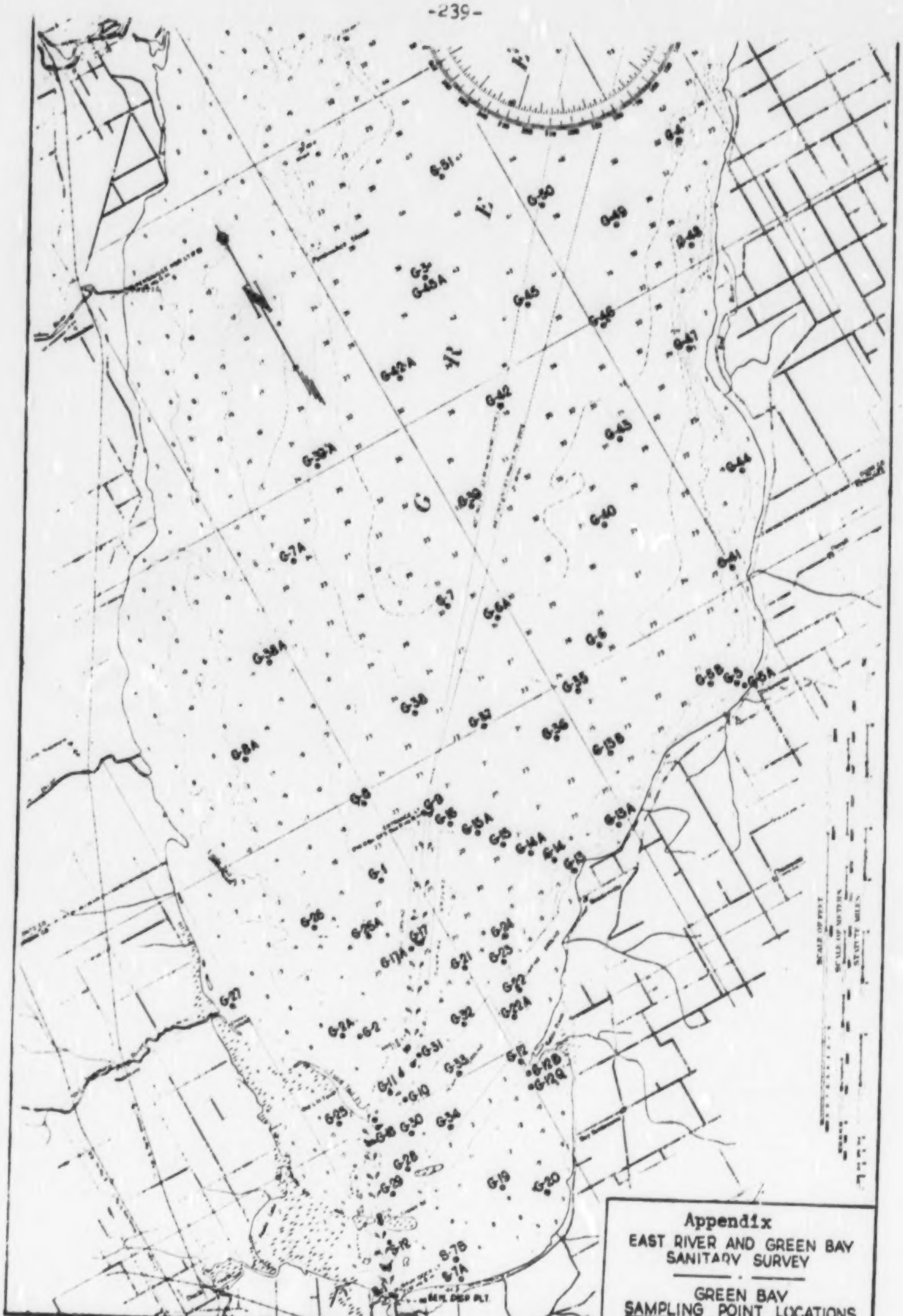
*FLOW DATA FROM U.S.G.S. GAGING STATION BELOW KOSS, MICHIGAN

APPENDIX VII.

BOTTOM FAUNA DATA, 1939 AND 1952



Appendix
EAST RIVER AND GREEN BAY
SANITARY SURVEY

GREEN BAY
SAMPLING POINT LOCATIONS

Wisconsin State Committee on Water Pollution (1939)

Appendix (Continued)

BOTTOM FAUNA — GREEN BAY

Sample No.	Date 1938–1939	Station No.	Station Depth Ft.	Character of Bottom	Non-Mollusca			Mollusca				
					Number per sq. ft.			Clams		Snails		
					Tubificidae	Chironomidae	Hexagenia	Musculium	Pisidium	Viviparidae	Valvata	Amnicolidae
B 16	11/16	S 1	15	Mucky mud	100	8						
B 17	11/16	S 2	6	Mucky mud	1600	16						E.S.**
B 18	11/16	S 3	5	Sandy mud	1200	40						E.S.
B 19	11/16	S 6	5	Mud	600	74						
B 20	11/16	S 7	6	Mucky mud	1100	34						
B 21	11/16	S 7A	6	Sand and gravel	270	40						
B 22	11/16	S 8	7	Sandy mud	250	90						
B 23	11/16	S 11	20	Sludge-like	2200	270						
B 24	11/16	S 10	8	Mucky mud	600	240		X *				
B 25	11/16	S 5	9	Mud	170	42						
B 26	11/16	S 4	20	Sludge-like	200	20						
B 28	11/17	G 1	24	Clayey mud	2	2					X	
B 29	11/17	G 2	13	Sandy mud	1	4	5	X	X	X	E.S.	
B 33	11/23	G 3	35	Mucky mud	24	26			X			
B 34	11/23	G 4	32	Sandy mud		22						
B 35	11/23	G 5	10	Hard sand								
B 36	11/23	G 6	30	Sandy mud	2	38			X			
B 37	11/23	G 7	35	Mucky mud		72			X			
B 38	11/23	G 8	26	Mud		10	2	X	X	X	X	E.S
B 39	11/23	G 9	20	Sandy mud			1	X	X		X	E.S
B 40	11/25	G 10	13	Sand	4			E.S.				
B 41	11/25	G 11	21	Mud	8	100	18					
B 43	11/25	G 14	21	Sandy mud	2	40		X				
B 44	11/25	G 15	24	Mud		28			X	X	X	X
B 45	11/25	G 16	25	Mud	8	22			X		X	X
B 46	11/25	G 17	27	Mud	2	38			X		X	
B 48	1/31	S 12	6	Sludge-like	1400	140						E.S.
B 49	1/31	S 7B	8	Mud, sand, gravel	70	58						
B 50	1/31	G 12B	4	Sand	4	2						
B 51	1/31	G 12C	12	Mucky mud	60	64	8					
B 52	1/31	G 19	12	Mucky mud	40	80						
B 54	2/7	G 23	11	Sandy mud	20	64						E.S.
B 55	2/7	G 22A	12	Sand and gravel	3	4						
B 56	2/7	G 22	14	Sand	2	2		E.S			X	
B 57	2/7	G 21	21	Mucky mud		22	4		X			E.S.
B 58	2/7	G 24	17	Sandy mud	6	8	2		X		X	E.S.
B 59	2/7	G 13A	19	Hard mud		16	2					E.S.
B 60	2/8	G 28	3	Sand		2		E.S.				
B 61	2/8	G 30	6	Sand	4	2		X				E.S.
B 62	2/8	G 10	15	Sandy mud	1	19	12		X			E.S
B 63	2/8	G 31	21	Sandy mud	4	160	50	X				
B 64	2/8	G 32	15	Sand		16	6	X	X			E.S.
B 65	2/8	G 33	12	Sand				E.S.				
B 66	2/8	G 34	5	Sand		0	2	E.S.	E.S.			
B 67	2/18	G 6	30	Mucky mud	4	34	2		X			
B 68	2/18	G 7	30	Mucky mud	2	25			X			E.S.
B 69	2/18	G 14A	24	Mud		25	2		X			
B 70	2/18	G 35	27	Mud	6	30			X		X	
B 71	3/25	G 5	24	Sandy mud		4			X			
B 72	3/25	G 9	26	Sandy mud		2	2		X		X	
B 73	3/25	G 14B	25	Sandy mud		26	2		X			

(* X – Entire animal)
(** E.S. – Empty shells)

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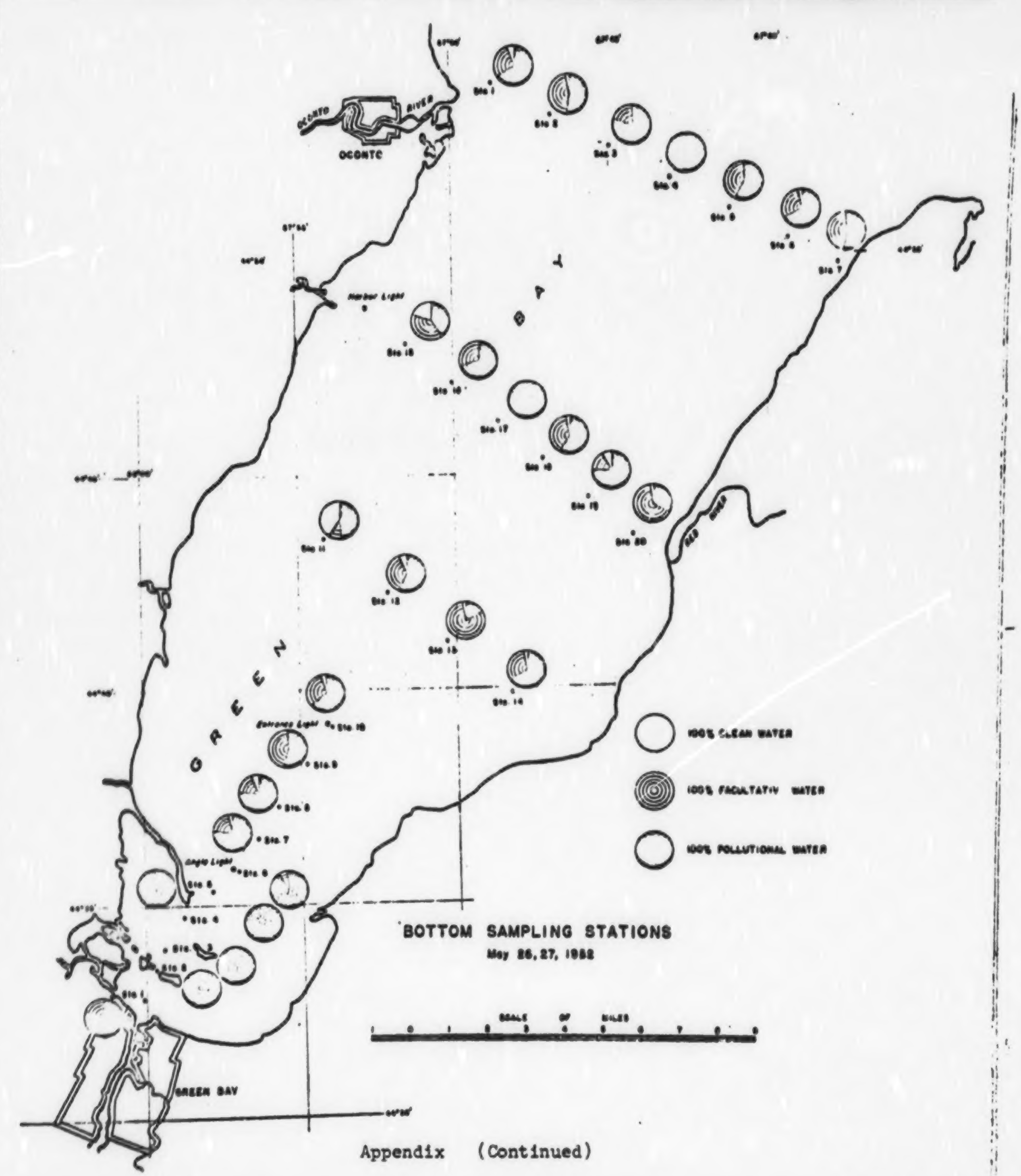
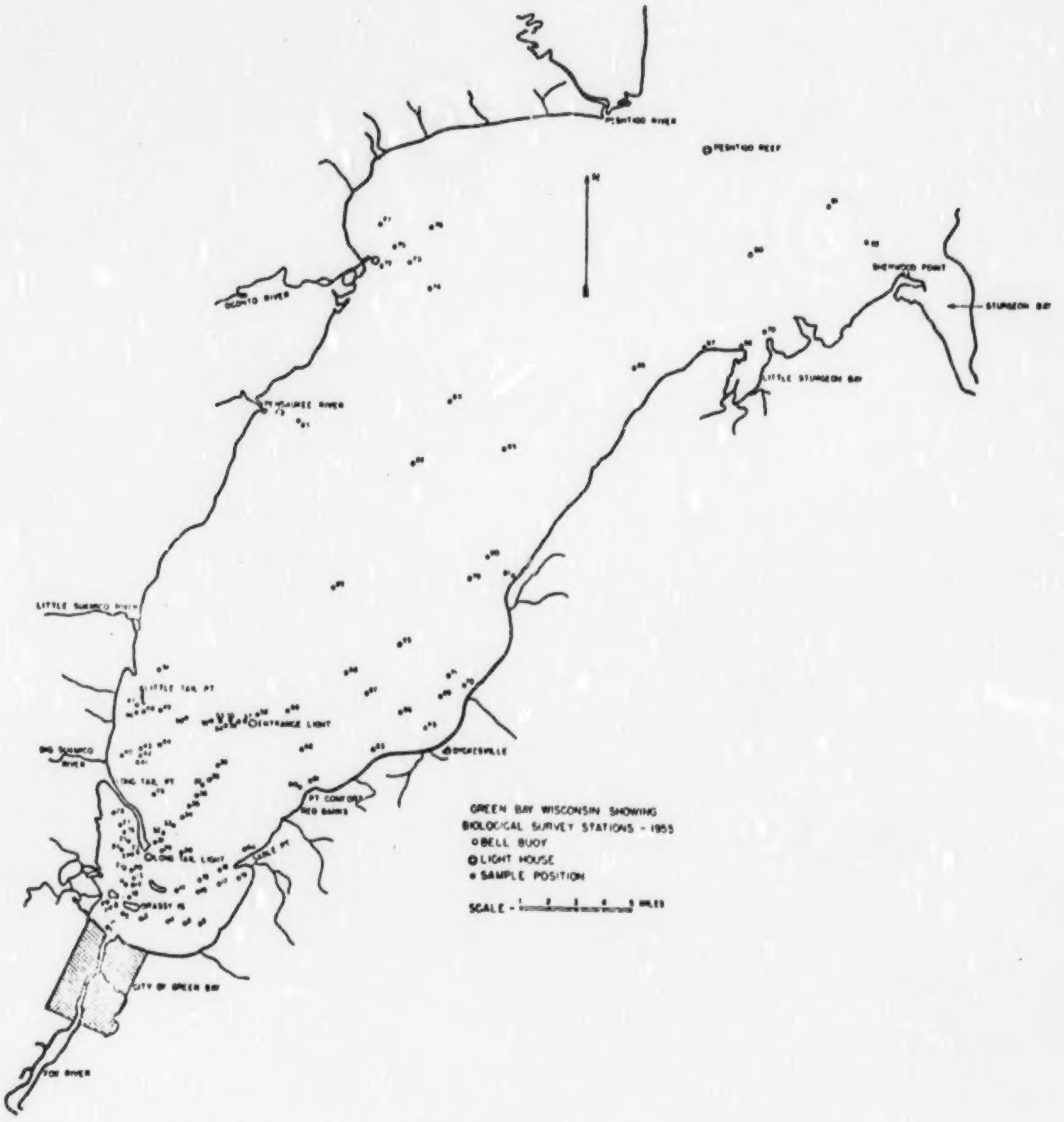


Appendix (Continued)

Surber and Cooley (1952)

APPENDIX VIII.

BOTTOM FAUNA DATA, 1955/1956



Appendix VIII.

Balch et al, 1956

Appendix VIII (Continued)

GREEN BAY BIOLOGICAL STUDIES - 1955
SUMMARY TABLE OF BOTTOM DWELLING ORGANISMS

Part 1 - Inner Green Bay
Figures Represent Numbers of Organisms Per Square Foot
Letters Indicate Relative Numbers

Scientific Name	Common Name	Position 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
B. Tolerant																														
		X	-	-	-	-	-	-	X	-	X	-	X	X	-	-	-	-	-	-	-	X	-	-	-	X	-	-	X	-
Pentaneura sp.	Midge Larvae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12	-	16	-	-	-	-	-	-	-	-	-	-	-	-
Cryptochironomus sp.	Midge Larvae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	4	F	-	-	-	-	-	-	-	-	-
Procladius sp.	Midge Larvae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tanytarsus (Stictochironomus)	Midge Larvae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Diamesa sp.	Midge Larvae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Unidentified Tendipedidae	Midge Larvae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spharium sp.	Fingernail Clam	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	44
Hyalella azteca	Scud	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Asellus militaris	Sow Bug	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Viviparus sp.	Snail	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	F	-	-	-	-	-	-	-	-	12
C. Very Tolerant																														
Tubificidae	Worm	-	56	0	40	0	0	0	-	16	-	4	-	-	196	200	108	220	V	244	-	-	F	F	8	-	40	32	-	12
Tendipes plumosus	Midge Larvae	-	-	-	4	0	0	0	-	8	-	4	-	-	12	8	4	4	-	4	F	-	F	F	4	-	-	16	-	4
Tendipes decorus	Midge Larvae	-	-	-	-	0	-	0	-	8	-	-	-	-	-	-	-	-	-	-	-	-	F	F	4	-	-	-	-	-

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Appendix VIII (Continued)

GREEN BAY BIOLOGICAL STUDIES - 1955
SUMMARY TABLE OF BOTTOM DWELLING ORGANISMS

Part 2 - Middle Green Bay

Scientific Name	Common Name	Position																																			
A. Intolerant		29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
		-	-	-	-	-	-	X	-	-	X	-	-	-	-	-	X	-	-	-	-	-	-	X	-	-	-	-	-	-	X	-	-	-	-	X	-
Athripsodes	Caddis Fly Larvae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	F	-	-	-	-
B. Tolerant																																					
Sphaerium	Fingernail Clam	-	-	-	-	-	-	-	-	-	-	-	-	-	64	4	-	16	-	-	8	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pisidium sp.	Fingernail Clam	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	-	-	-	-	-
Procladius sp.	Midge Larvae	-	-	-	-	-	-	-	-	-	-	-	8	70	4	-	-	-	-	-	-	24	18	-	-	12	22	4	-	4	-	16	-	2	22	-	4
Pentaneura sp.	Midge Larvae	-	-	-	-	-	-	-	-	-	-	-	20	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	2	12	-	-
Pseudochironomus sp.	Midge Larvae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	F	-	-	-	-
Tendipes fumidus	Midge Larvae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	F	-	-	-	-
Anatopynia sp.	Midge Larvae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-
Cryptochironomus	Midge Larvae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4	-	-	-	-	-	-	-
Unidentified Tendipedidae	Midge Larvae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-
Tanytarsus sp. (Stictochironomus)	Midge Larvae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	-	-	-	2	-	-	-	-	-	-	-	-	-	-
Hyalella azteca	Scud	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	F	F	-	-	1
Gammarus sp.	Scud	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-
Unionidae	Clam	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	2	-	-	-	-	-	4	-	4	-	-	-	-	-	-	-	-	1
Viviparus sp.	Snail	-	-	-	-	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	24	-	4	-	-	-	-	-	-	-	-	-
Asellus sp.	Sow Bug	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	-	-	-	-	-	-	-	N	-	-	-
Hirudinea	Leech	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	24	-	-	-	-	-	-	-
C. Very Tolerant																																					
Tubificidae	Worm	16	4	24	20	28	4	-	4	8	-	-	-	8	-	8	-	-	16	14	4	2	10	-	28	24	40	16	64	-	-	26	-	5	20	-	4
Stylaria fossularis	Worm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16	-	-	-	2	-	-	-
Tendipes plumosus	Midge Larvae	4	-	8	-	-	4	-	-	-	-	-	12	-	-	8	-	12	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
Tendipes decorus	Midge Larvae	4	-	-	-	-	8	-	-	-	-	8	12	14	12	8	-	-	-	14	-	6	8	-	-	8	50	8	40	28	-	14	-	48	6	-	5

Appendix VIII (Continued)

GREEN BAY BIOLOGICAL STUDIES - 1955
SUMMARY TABLE OF BOTTOM DWELLING ORGANISMS

Part 3 - Outer Green Bay

Scientific Name	Common Name	Position																												
		65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93
A. Intolerant																														
Ephemera guttulata	May Fly Nymph	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stenonema sp.	May Fly Nymph	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	F	-	-	-	-	-	-	F	-	-	-	-	-
Cheumatopsyche sp.	Caddis Fly Larvae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	F	-	-	-	-	-	F	F	-	-	-	-	-
Psephenidae	Water Penny	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	F	-	-	-	-	-	-
B. Tolerant																														
Asellus militaris	Sow Bug	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12	F	-
Sphaerium sp.	Fingernail Clam	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	24	-	-
Pisidium	Fingernail Clam	-	-	2	10	-	-	-	-	2	1	5	-	5	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-
Procladius sp.	Midge Larvae	5	10	38	2	-	-	60	44	30	-	6	-	-	-	-	100	-	4	-	-	-	12	-	-	12	20	-	F	6
Anatopynia sp.	Midge Larvae	-	-	-	-	4	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pseudochironomus sp.	Midge Larvae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	F	-	-	-	-	-	-	-	-	-	-	-	-
Harnischia sp.	Midge Larvae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12	-	-	-	-	-	-	-
Diamesa fulva	Midge Larvae	-	-	-	-	-	-	-	-	-	-	-	-	36	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cryptochironomus sp.	Midge Larvae	-	-	2	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-
Tanytarsus (Stictochironomus)	Midge Larvae	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hyalella azteca	Scud	-	-	-	-	-	-	-	-	-	-	1	F	1	-	-	-	-	-	-	-	-	-	F	F	-	-	-	-	-
Helisoma sp.	Snail	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Amnicola limosa	Snail	-	-	-	-	-	-	-	-	-	13	8	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pleurocera acuta	Snail	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Valvata tricarinata	Snail	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Gordius sp.	Worm	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dugesia tigrina	Flatworm	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C. Very Tolerant																														
Tubificidae	Worm	8	24	68	22	32	-	36	8	130	6	19	-	34	24	16	74	F	28	6	24	20	52	-	-	8	16	-	-	52
Lumbriculidae	Worm	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stylaria fossularis	Worm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-
Nais sp.	Worm	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tendipes decorus	Midge Larvae	17	25	10	10	4	4	4	-	20	-	-	-	-	4	-	12	-	-	-	-	4	8	-	-	4	8	-	-	4
Tendipes plumosus	Midge Larvae	6	8	-	4	-	-	2	32	-	-	-	-	-	8	12	6	-	4	-	20	8	12	-	-	-	4	-	-	2
Helobdella stagnalis	Leech	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

X = Nothing in sample.
F = Few = 0-10
M = Moderate = 10-25

P = Profuse = 25-100
V = Very profuse = 100 up
O = Organisms present—no numbers indicated.

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APPENDIX IX.

CHEMICAL DATA
GREEN BAY
1939

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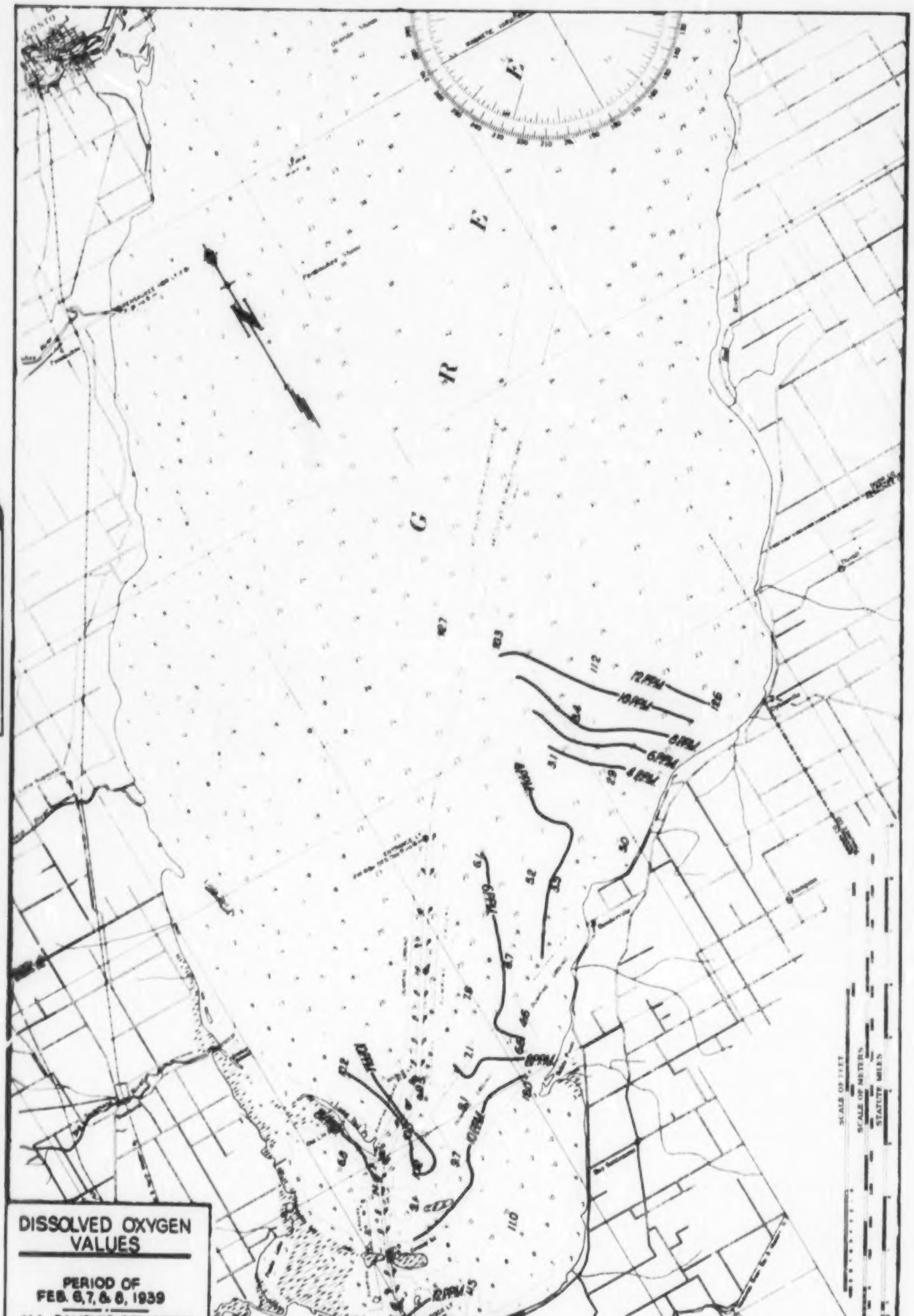
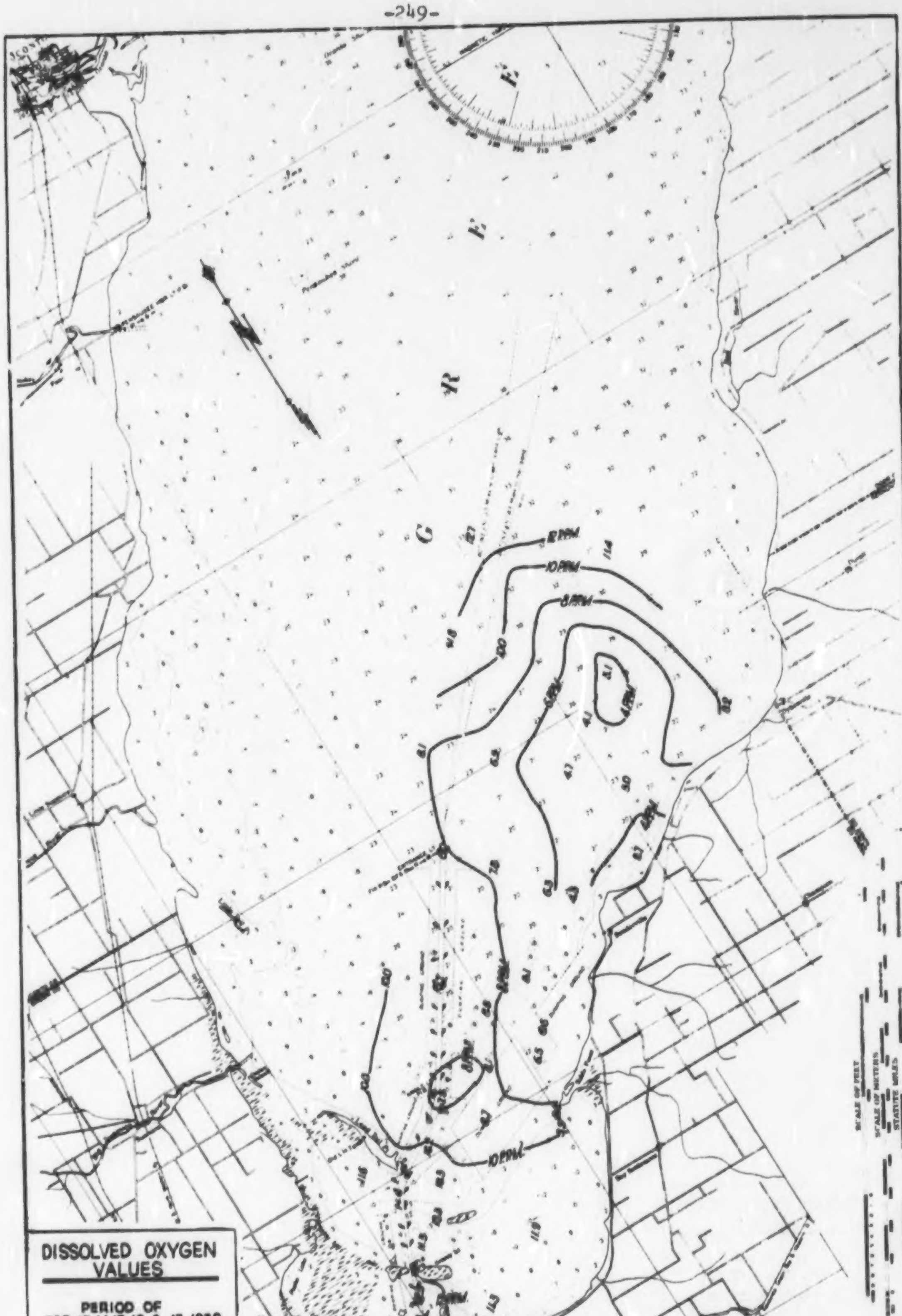


DISSOLVED OXYGEN VALUES

PERIOD OF
FEB. 6, 7, & 8, 1939

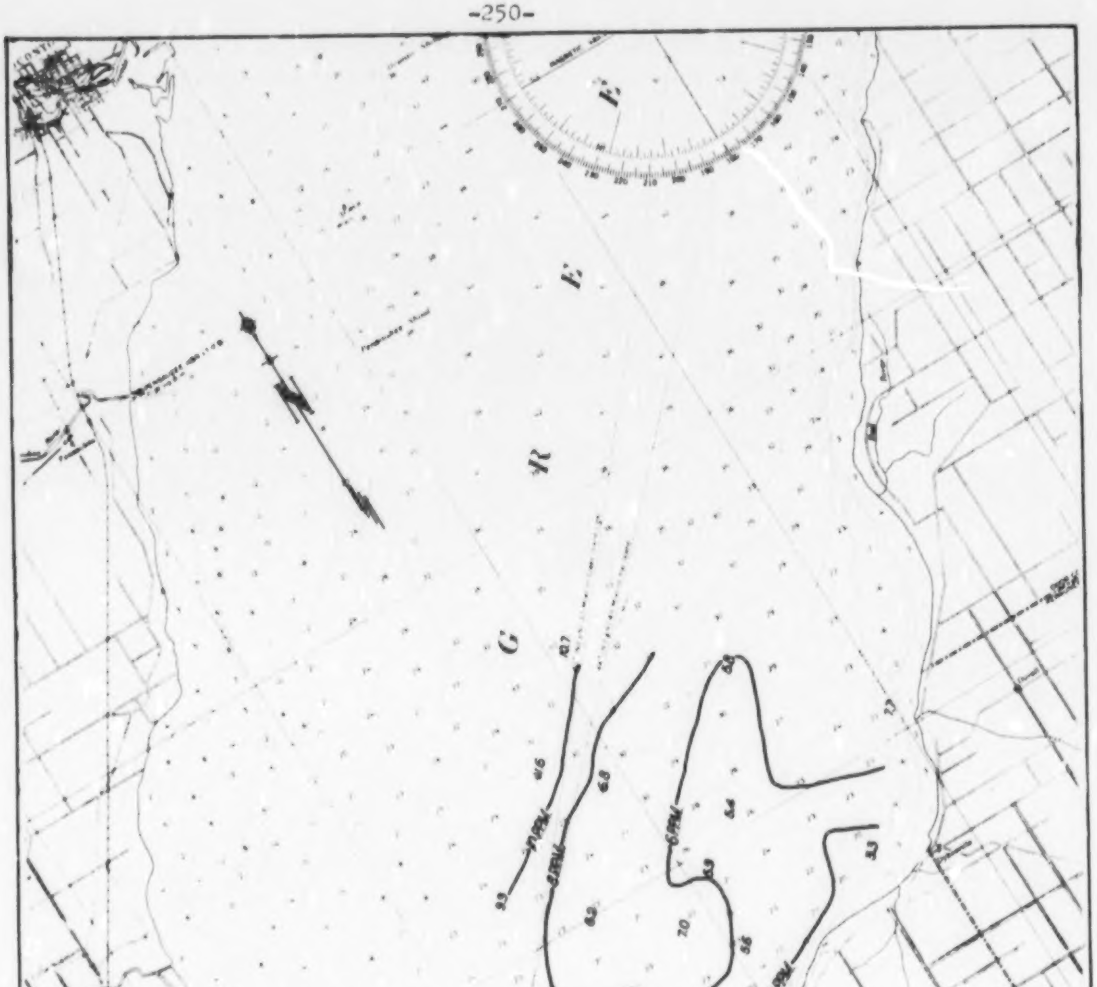
ALL SAMPLES COLLECTED
AT 3-FT. DEPTH



DISSOLVED OXYGEN VALUES

PERIOD OF
FEB. 13, 14, 15, 16 & 17, 1939

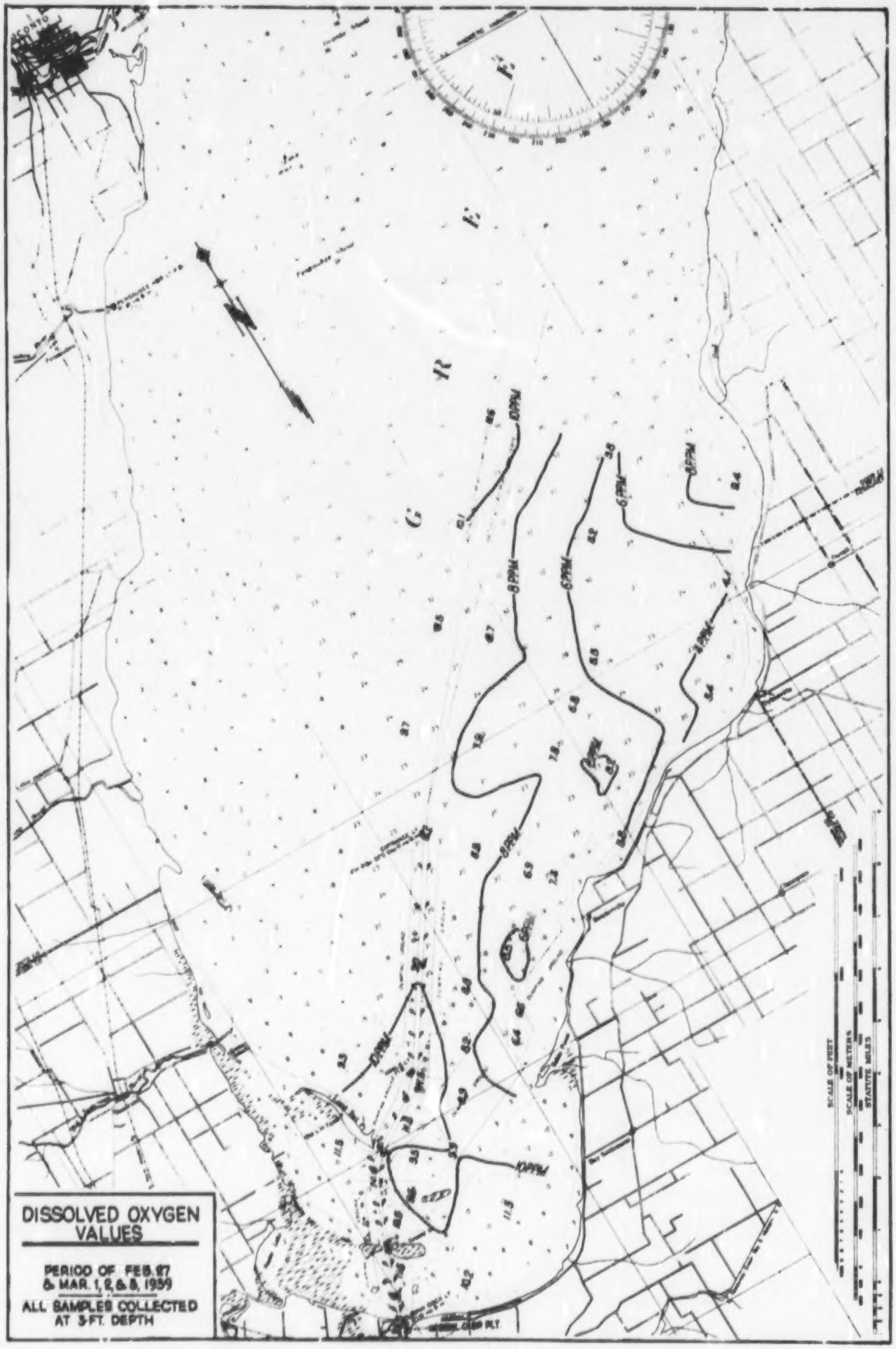
ALL SAMPLES COLLECTED
AT 3-FT. DEPTH



DISSOLVED OXYGEN VALUES

PERIOD OF FEB. 20, 21 & 22, 1939

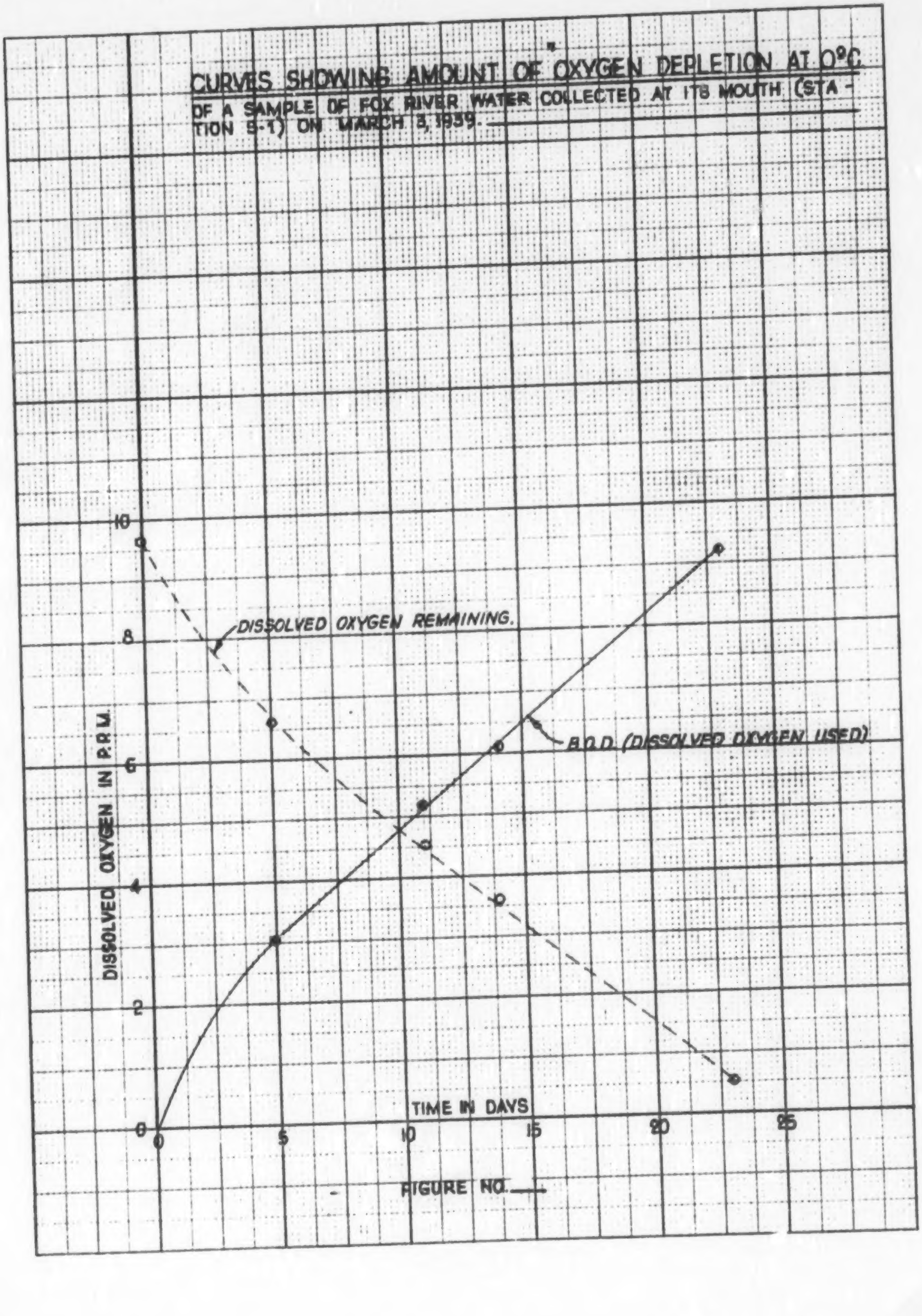
ALL SAMPLES COLLECTED AT 3-FT. DEPTH



DISSOLVED OXYGEN VALUES

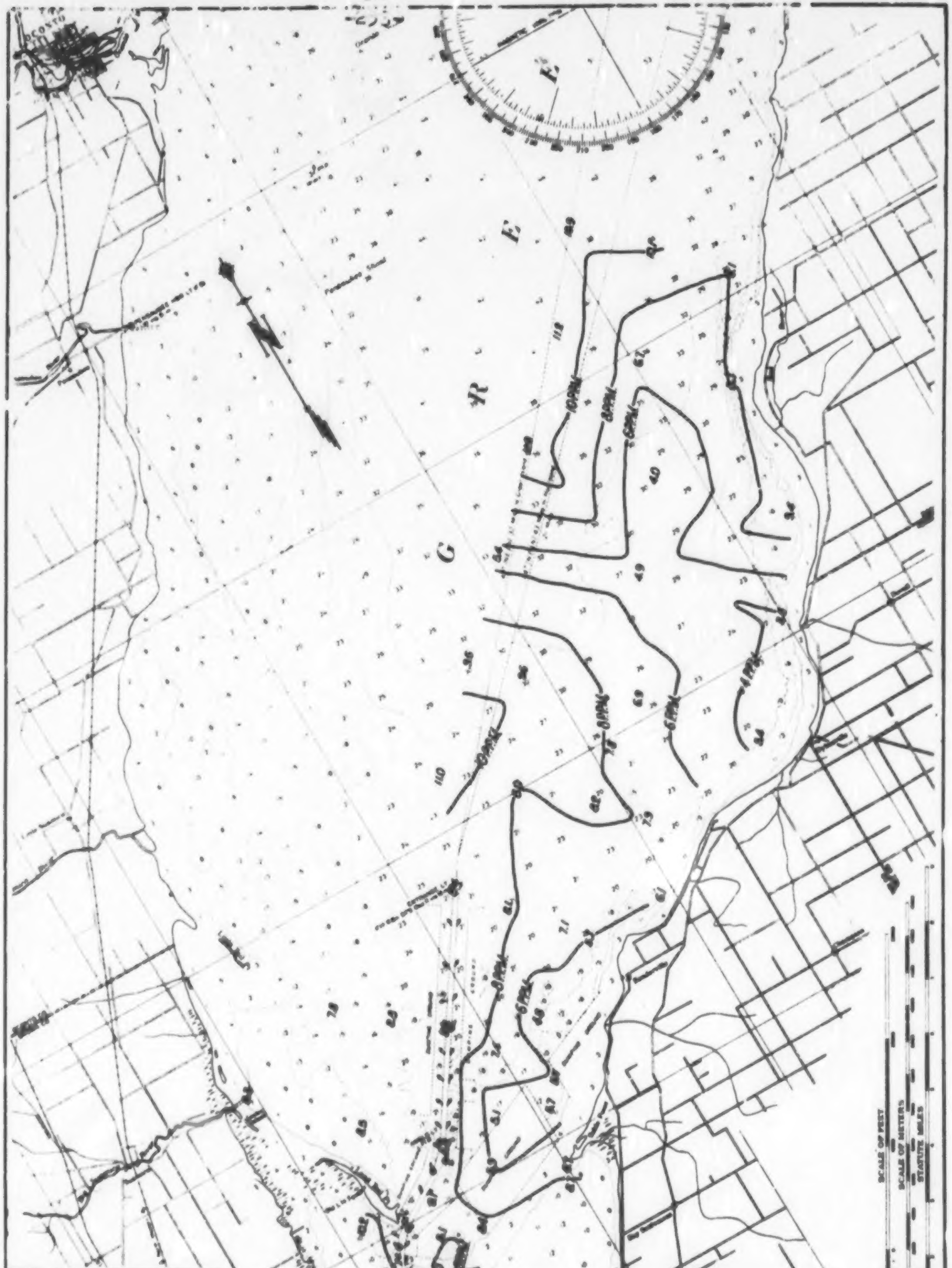
PERIOD OF FEB.27 & MAR. 1, 2, & 3, 1939

ALL SAMPLES COLLECTED AT 3 FT. DEPTH



CURVES SHOWING AMOUNT OF OXYGEN DEPLETION AT 0°C OF A SAMPLE OF FOX RIVER WATER COLLECTED AT ITS MOUTH (STATION 5-1) ON MARCH 3, 1939.

FIGURE NO.___



DISSOLVED OXYGEN VALUES

PERIOD OF
MAR. 6, 7, 8, & 9, 1939

ALL SAMPLES COLLECTED
AT 3-FT. DEPTH

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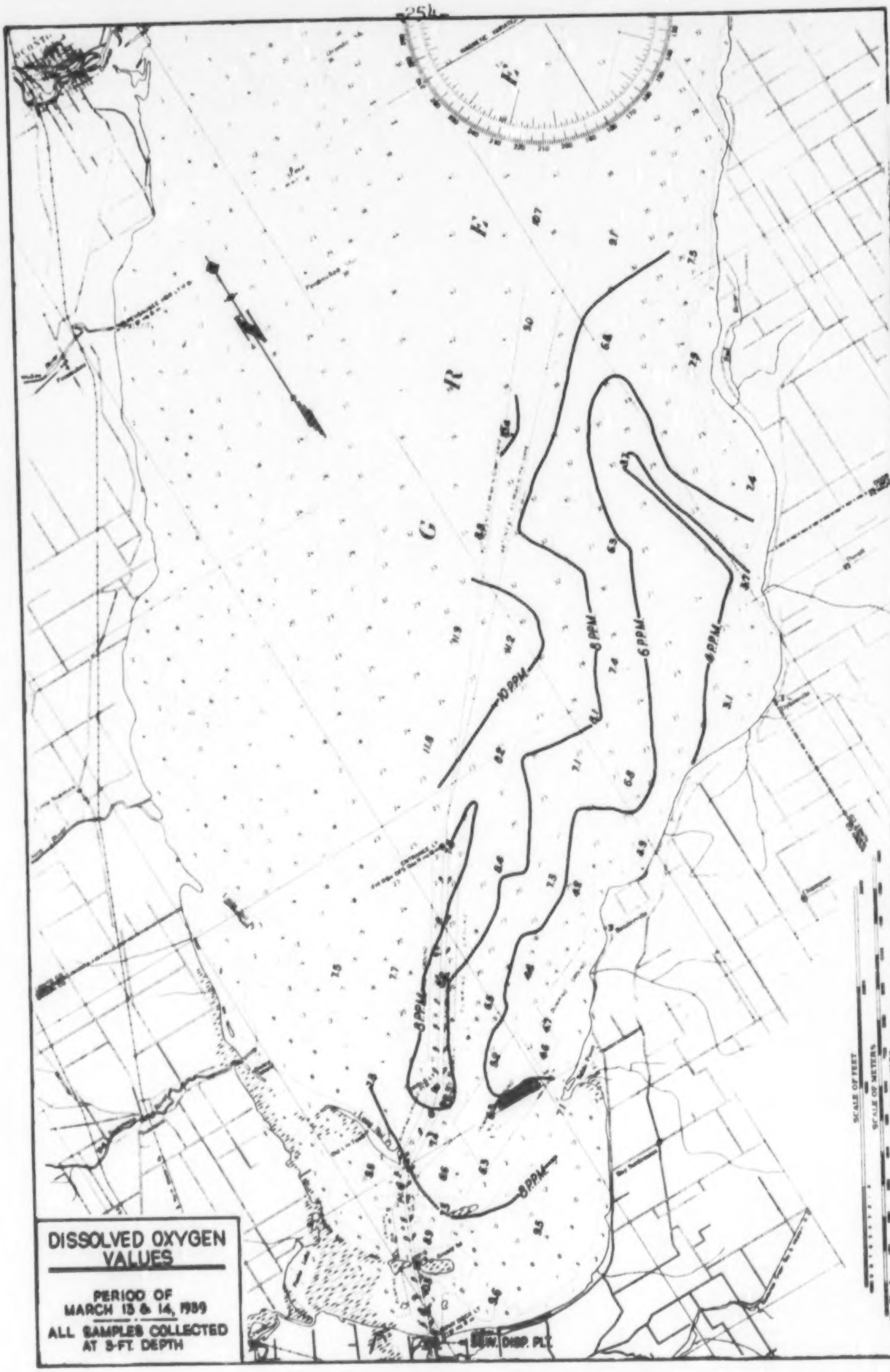
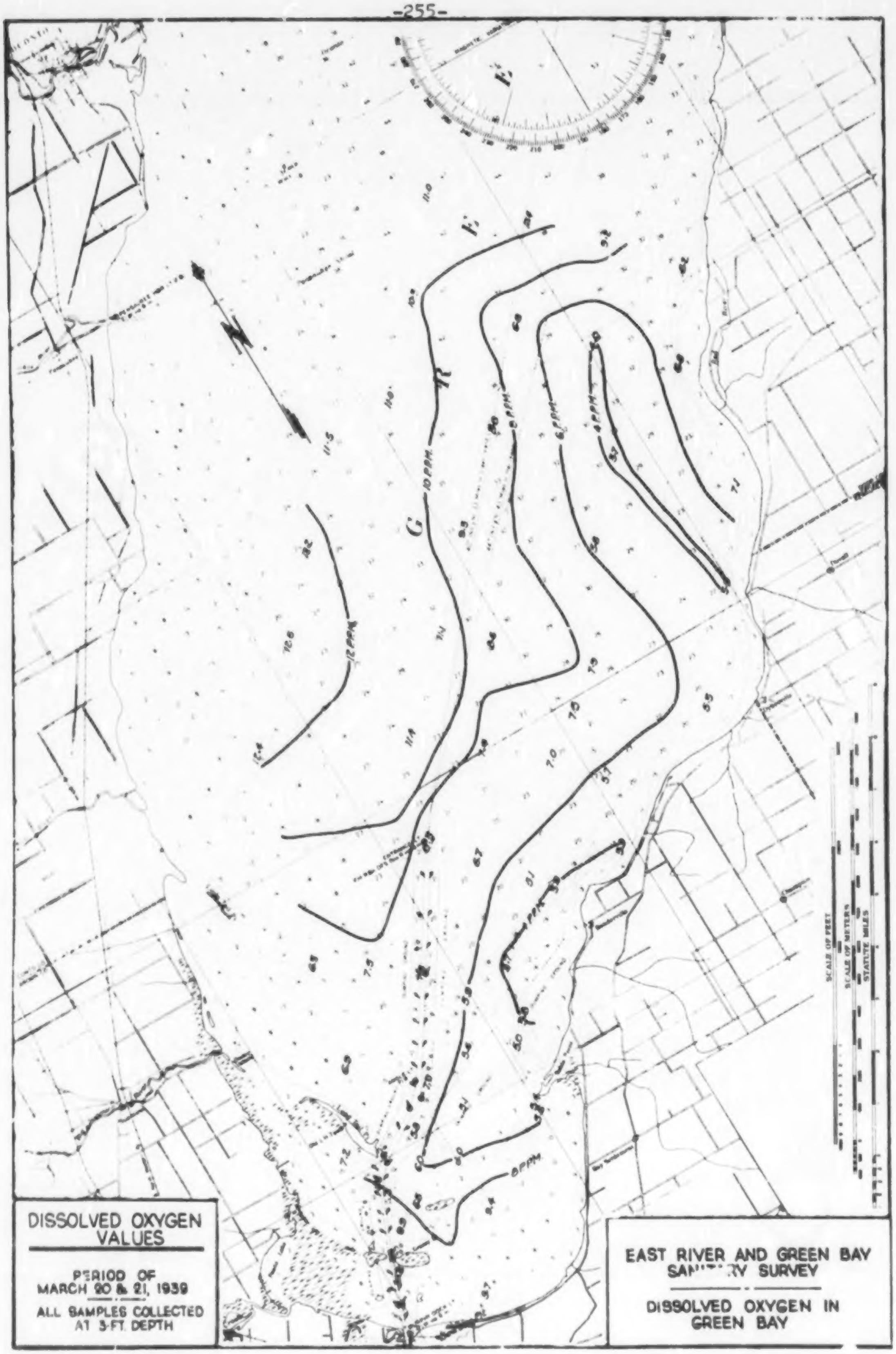


DISSOLVED OXYGEN VALUES

PERIOD OF
MARCH 13 & 14, 1939

ALL SAMPLES COLLECTED
AT 3-FT. DEPTH



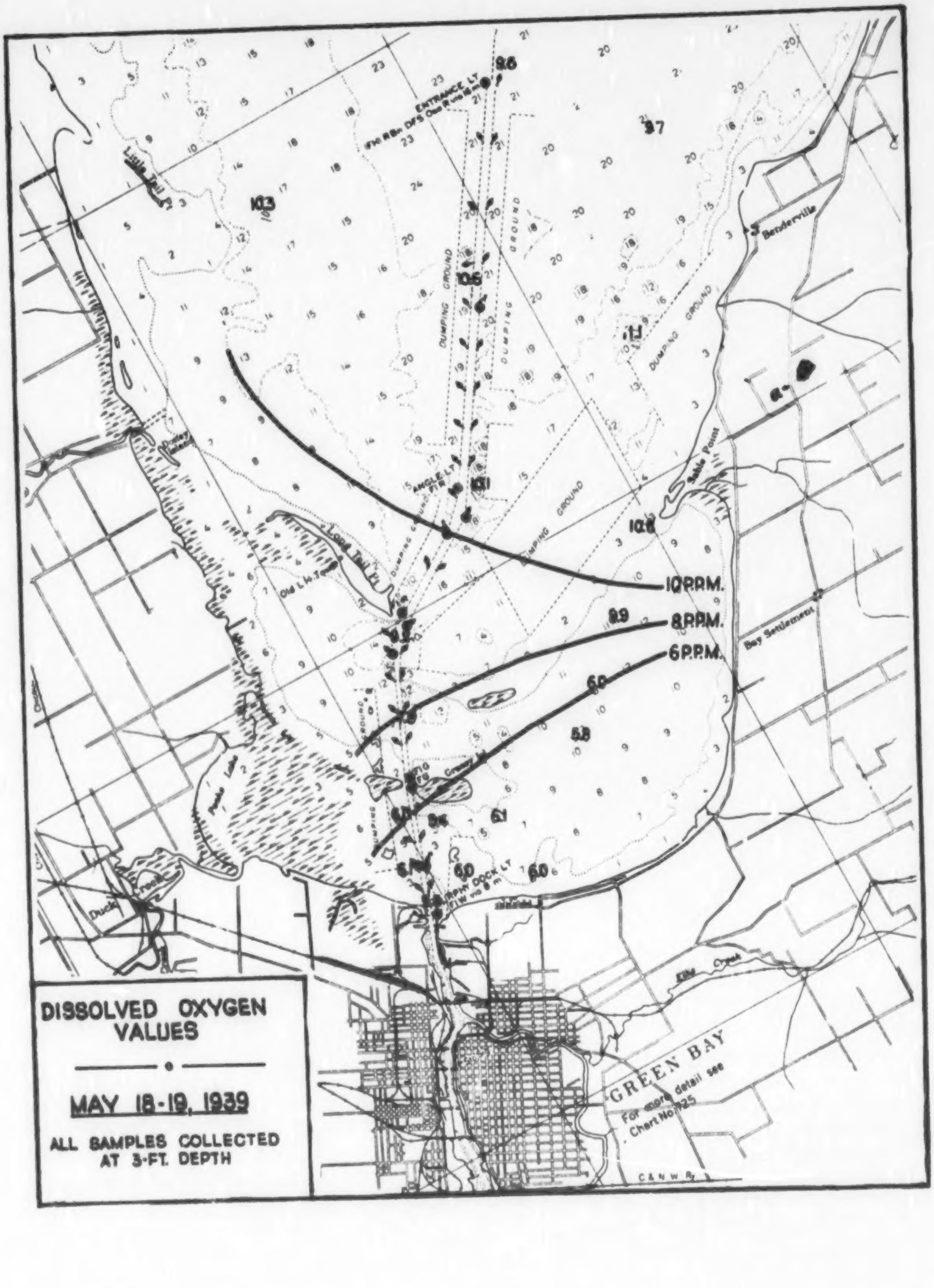
DISSOLVED OXYGEN VALUES

PERIOD OF
MARCH 20 & 21, 1939

ALL SAMPLES COLLECTED
AT 3-FT. DEPTH

EAST RIVER AND GREEN BAY
SANITARY SURVEY

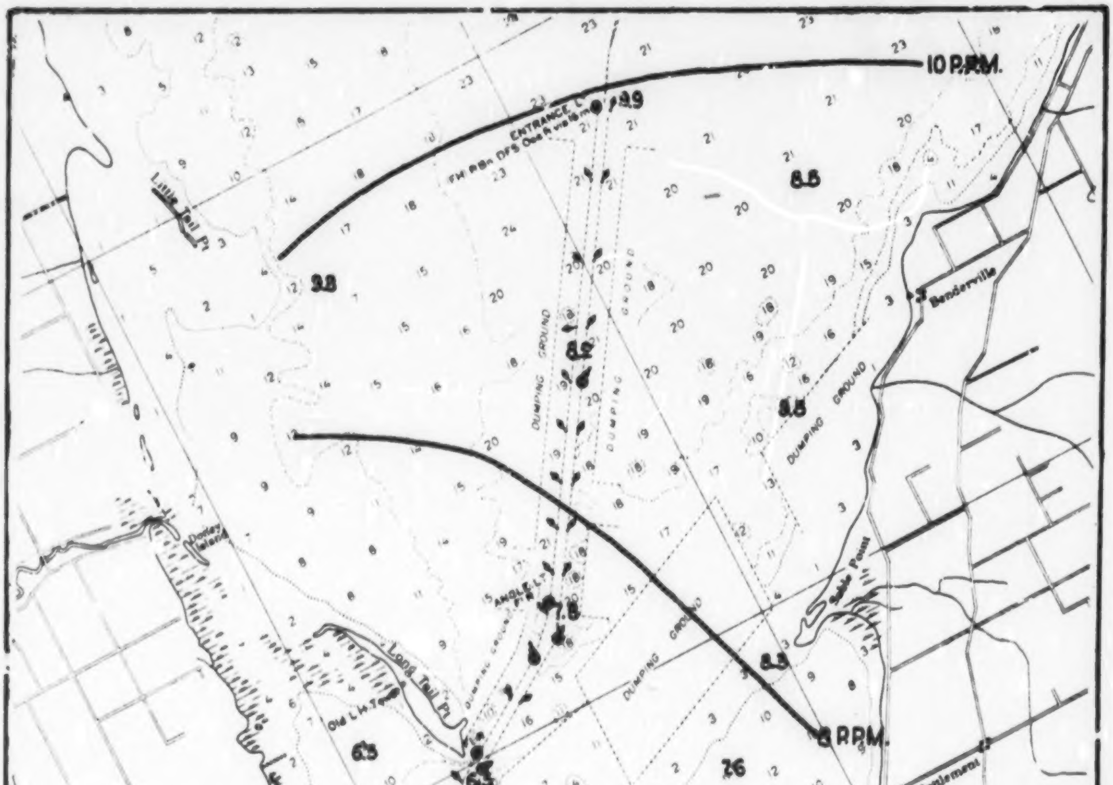
DISSOLVED OXYGEN IN
GREEN BAY



DISSOLVED OXYGEN VALUES

MAY 18-19, 1939

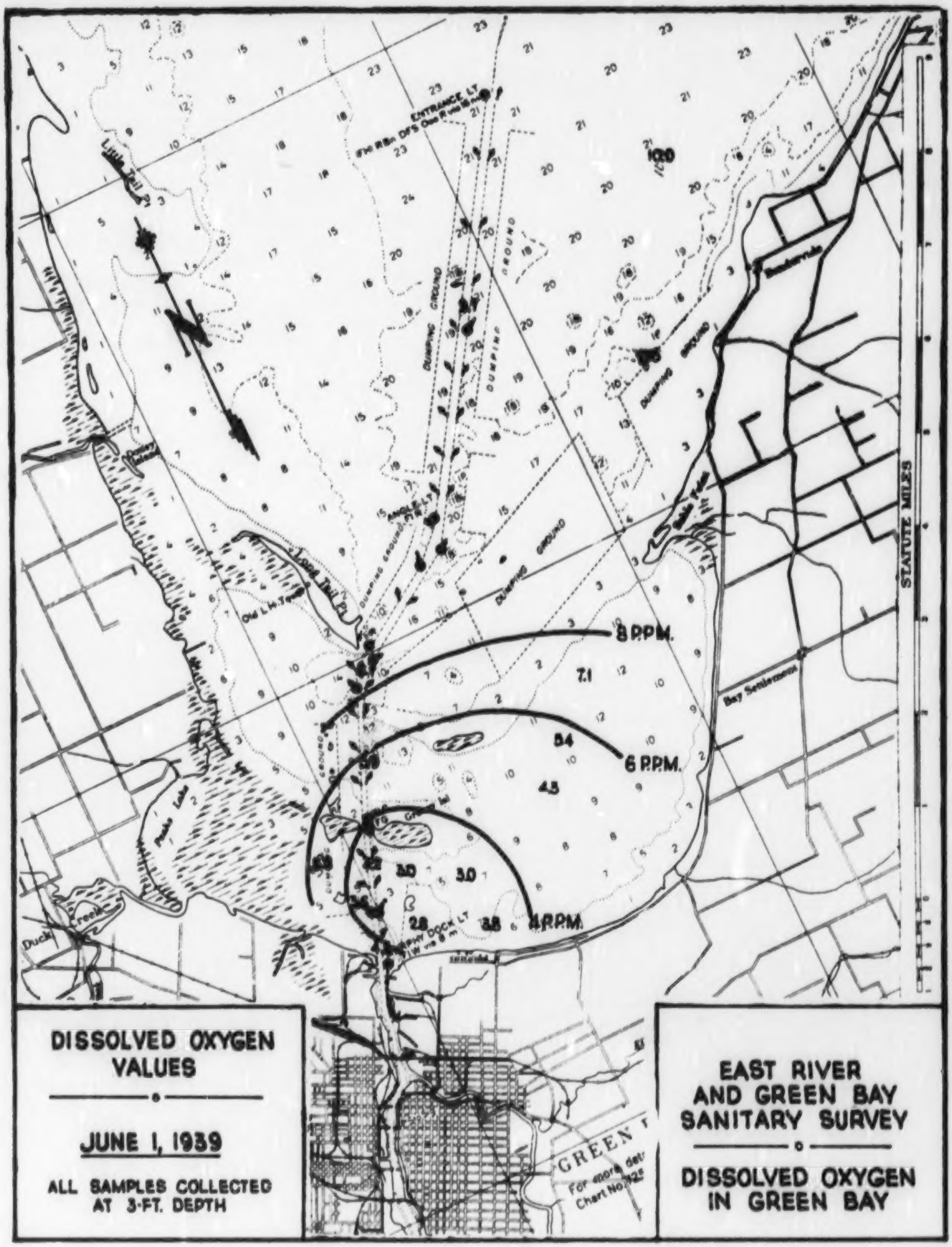
ALL SAMPLES COLLECTED AT 3-FT. DEPTH



DISSOLVED OXYGEN VALUES

MAY 25-26, 1939

ALL SAMPLES COLLECTED AT 3 FT. DEPTH



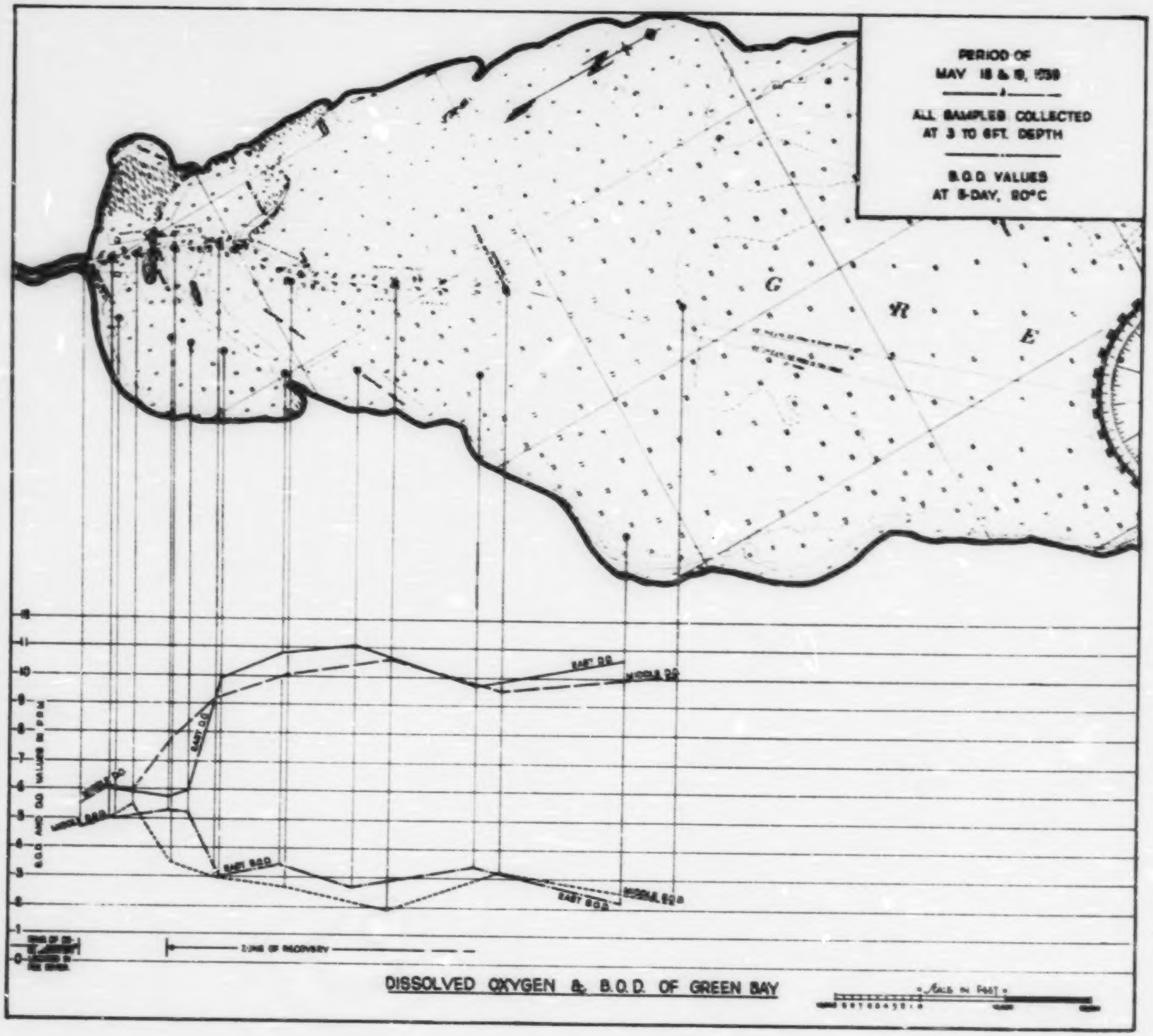
DISSOLVED OXYGEN VALUES

JUNE 1, 1939

ALL SAMPLES COLLECTED AT 3-FT. DEPTH

EAST RIVER AND GREEN BAY SANITARY SURVEY

DISSOLVED OXYGEN IN GREEN BAY



DISSOLVED OXYGEN & B.O.D. OF GREEN BAY

DISSOLVED OXYGEN AND pH DATA

Station	Date	Time	Ice (In.)	Snow (In)	Total Depth (Ft.)	Sampling Depths											
						3 Feet				Middle							
						°C. Temp.	pH	D.O. PPM	% Sat.	°C. Temp.	pH	D.O. PPM	% Sat.	°C. Temp.	pH	D.O. PPM	% Sat.
S-1	10- 4-38	2:35PM	-	-	-	16	8.7	8.3	83.5	-	-	-	-	-	-	-	-
•	10- 6-38	10:10AM	-	-	-	15	8.5	6.2	81.0								
•	10-12-38	1:55PM	-	-	-	16	8.6	8.6	86.4								
•	10-19-38	3:20PM	-	-	-	14	7.7	6.7	64.6								
•	10-26-38	11:00AM	-	-	-	10.5	7.7	9.5	84.7								
•	11- 2-38	11:20AM	-	-	-	11	7.0	5.1	40.1								
•	11-16-38	10:30AM	-	-	-	3	7.5	10.3	76.5								
•	1-16-39	9:45AM	2	-	25	0	7.3	12.5	85.5					0.0	7.3	12.5	85.5
•	2- 8-39	9:30AM	5	1	22	-	7.3	12.4						-	7.4	12.1	
•	2-17-39	4:00PM	6	0-1	27	-	7.4	12.4						-	7.4	12.5	
•	2-22-39	3:00PM	6	0	24	-	-	12.4						-	-	12.4	
•	3- 3-39	11:00AM	6	0-½	25	-	7.7	11.5						-	7.6	11.5	
•	3- 9-39	2:30PM	6	½-1	25	-	7.6	11.8						-	7.6	11.4	
•	3-14-39	11:50AM	4	2-3	24	-	7.5	10.8						-	7.5	10.8	
•	3-14-39	4:00PM	4	2-3	24	-	-	10.5						-	-	10.1	
•	5- 4-39	3:15PM	0	0	27	13.0	8.3	9.5	89.5	13.0	8.3	9.5	89.5	13.0	6.3	9.6	90.5
•	5-19-39	1:15PM	0	0	26	-	7.6	5.5		-	7.6	5.6		-	7.6	5.3	
•	5-25-39	5:20PM	0	0	30	13.0	-	6.3	71.4	18.0	-	6.7	70.4	18.0	-	6.6	66.4
•	6- 1-39	7:20AM	-	-	27	22.0	7.6	4.5	51.0	21.5	7.6	4.1	46.0	21.0	7.6	3.2	35.6
S-3A	5-19-39	1:30PM	0	0	5	-	7.6	6.0									
•	5-25-39	12:30PM	0	0	6	17.0	-	5.0	51.5								
•	6- 1-39	8:45AM	-	-	6	22.5	7.5	2.8	31.9								
S-4	5-19-39	5:05PM	-	-	30	-	7.7	6.1		-	7.7	6.0		-	7.7	6.3	
•	5-25-39	5:10PM	-	-	25	18.0	7.7	6.5	53.3					18.0	-	6.0	63.0
•	6- 1-39	7:45AM	-	-	27	21.5	7.5	3.6	47.3	21.5	7.4	3.3	37.0	19.0	7.5	4.3	46.0
S-7A	10-14-38	3:00PM	-	—	-	17	8.4	8.1	83.4								
•	10-19-38	4:05PM	-	-	-	14	8.0	4.8	40.4								
•	11-16-38	11:45AM	-	-	-	3	7.4	11.4	84.5								
S-7B	1-10-39	-	6	-	7.5									0.0	7.3	11.6	79.1
•	1-20-39	1:00PM	10	2	7.5									0.4	7.4	11.5	79.6
•	2- 3-39	10:30AM	-	-	7.5									-	7.3	11.0	
•	2- 8-39	10:25AM	16	1½	7.0	-	7.4	11.5						-	7.3	11.2	
•	2-17-39	3:00PM	14	0-1	6									-	7.4	11.3	
•	2-21-39	AM	18	0-1	7		7.6	11.3						-	7.5	11.1	
•	3- 3-39	10:00AM	24	Dr.*	7	-	-	10.2							7.4	10.1	
•	3- 9-39	1:30PM	20	1-4	7	-	7.4	10.0						-	7.4	10.7	
•	3-14-39	1:10PM	18	2-3	7	-	7.5	9.8						-	7.5	9.2	
•	3-22-39	Noon	19	0	8	-	7.1	9.7						-	7.1	9.1	
•	5-19-39	2:10PM	0	0	8	-	7.6	6.0									
•	5-25-39	1:15PM	0	0	8.5	16.5	-	4.7	53.1								
•	6- 1-39	9:15AM	-	-	7	22.5	7.5	3.8	43.4								
			(*Dr. – Drifts)														
S-10A	5-19-39	2:00PM	0	0	9	-	7.5	6.1									
•	5-25-39	1:00PM	0	0	9	16.5	-	4.9	49.6					16.5	-	5.0	50.7
•	6- 1-39	9:00AM	-	-	10	22.0	7.5	3.0	34.0					21.5	7.5	2.5	28.0
S-12	1-16-39	10:45AM	5	-	6.5									0.0	7.5	12.6	86.2
•	1-27-39	1:30PM	6	2	5									-	8.1	12.4	
•	2- 8-39	10:30AM	11	1	6	-	7.4	12.0									
•	2-17-39	3:30PM	14	0-1	5	-	7.4	12.3									

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(CONT.)

STATION	DATE	TIME	ICE (IN.)	SNOW (IN.)	TOTAL DEPTH (FT.)	SAMPLING DEPTHS — 3 FEET				MIDDLE				1 FOOT ABOVE BOTTOM			
						°C. TEMP.	PH	D.O. PPM	% SAT.	°C. TEMP.	PH	D.O. PPM	% SAT.	°C. TEMP.	PH	D.O. PPM	% SAT.
S-12	2-22-39	2:30PM	14	1	5	-	-	12.4									
"	3- 3-39	10:30AM	14	-	6			-						-	7.5	11.6	
"	3- 9-39	2:00PM	16	1-4	6			-						-	7.6	11.8	
"	3-14-39	11:20AM	13	2-3	6	-	7.5	10.3									
"	3-21-39	9:15AM	17	0	6.5	-	7.2	10.6									
"	5-19-39	1:45PM	0	0	7	-	7.4	5.4									
"	5-25-39	12:45PM	0	0	8	17.0	-	4.2	43.2								
"	6- 1-39	8:30AM	-	-	8	22.0	7.5	3.0	34.0								
S-13	5-19-39	2:30PM	0	0	12	-	7.6	5.8						-	7.6	5.1	
"	5-25-39	1:35PM	0	0	11	16.0	-	7.8	78.4					16.0	-	7.7	77.5
"	6- 1-39	9:30AM	-	-	12	22.5	7.6	4.3	49.1					21.0	7.6	5.0	55.6
S-14	5-19-39	4:50PM	-	-	30	-	7.7	6.0		-	7.7	5.9		-	7.7	6.3	
"	5-25-39	4:30PM	-	-	27	18.0	7.6	5.5	57.6	18.0	-	5.4	56.6	17.5	-	4.8	49.9
"	6- 1-39	8:20AM			30	22.0	7.5	3.2	35.2	21.0	7.5	3.9	43.4	19.5	7.5	4.5	48.7
S-15	5-25-39	4:30PM	-	-	6	17.0	7.7	6.7	63.3								
"	6- 1-39	8:30AM	-	-	9	22.0	7.7	5.3	65.6					21.5	7.7	5.1	57.2
G-1	11-16-38				24	5.0	8.1	12.2	95.3	5.0	8.1	12.2	95.3	5.0	8.1	12.3	96.0
G-2	11-16-39				14	4.0	8.1	12.7	96.6	4.0	8.1	12.6	95.3	4.0	8.1	12.7	96.6
G-2A	1-26-39	2:45PM	8	4	13	-	7.3	9.5						-	7.3	9.5	
"	2- 6-39	11:30AM	14	1	13	-	7.3	10.2						-	7.3	10.2	
"	2-15-39	10:45AM	15	1	12.5	-	7.3	10.0						-	7.3	9.5	
"	2-22-39	10:30AM	13	Dr.	12.5	-	7.2	10.0						-	7.3	9.7	
"	2-27-39	2:45PM	12	Dr.	12	-	7.6	9.3						-	7.4	10.2	
"	3- 9-39	1:15PM	19	7	14	-	7.4	8.5						-	7.4	8.2	
"	3-14-39	9:30AM	20	4-5	14	-	7.5	7.8						-	7.3	7.3	
"	3-21-39	2:00PM	13	0	13.5	-	7.1	6.9						-	7.2	6.8	
G-3	11-23-38	11:00AM	-	-	35	4.75	7.9	13.1	100.2	4.75	7.9	12.7	93.6	4.75	7.9	10.9	84.5
G-4	11-23-38	12:00AM	-	-	33	5.0	7.9	12.8	100.0	4.25				4.25	7.9	12.7	97.5
G-5	11-23-38	1:30PM	-	-	11	1.0	7.9	13.7	96.3					1.5	7.9	14.0	100.0
G-5A	1-18-39	1:30PM	-	-	5	1.0	7.5	13.2	92.6	1.0							
"	1-23-39	3:30PM	15	1	3	0.0	7.4	12.2	83.4								
"	1-27-39	10:20AM	18	1	7	-	7.6	12.2		-							
G-5B	1-18-39	1:00PM	10	4	24	0.1	7.5	13.2	90.2	0.2				1.0	7.5	12.2	85.7
"	1-23-39	3:00PM	15	1	24	0.0	7.4	9.9	67.7	0.6				-	7.3	9.7	
"	1-28-39	10:00AM	16	1	23	-	7.5	12.7		-	7.5	12.0		-	7.3	9.7	
"	2- 2-39	Noon	13	-	24	-	7.6	12.6		-	7.5	12.4		-	7.3	6.8	
"	2- 8-39	4:15PM	18	1	22	-	7.2	12.6		-	7.2	9.5		-	7.2	5.9	
"	2-15-39	9:30AM	18	1	23	-	7.2	8.2		-	7.2	3.5		-	7.2	3.3	
"	2-21-39	PM	20	1	23	-	7.1	3.3		-	7.1	3.2		-	7.1	3.0	
"	3- 1-39	10:00AM	30	Dr.	22	-	7.0	3.4		-	7.0	3.4		-	7.0	3.4	
"	3- 7-39	1:35PM	27	7	20	-	7.2	3.4		-	7.2	2.7		-	7.2	2.6	
"	3-13-39	3:00PM	20	½-2	23	-	7.2	3.1		-	-	-		-	7.2	3.3	
"	3-21-39	10:00AM	27	½-1	21	-	7.3	5.3		-	-	-		-	7.3	4.4	
"	4-25-39	11:00AM	0	0	24	4.2	7.5	12.4	95.2	4.0	7.5	12.6	95.7	4.1	7.5	12.4	94.5

(Cont.)

Station	Date	Time	Ice (In.)	Snow (In.)	Total Depth (Ft.)	Sampling Depths											
						3 Feet				Middle				1 Foot Above Bottom			
						°C. Temp.	pH	D.O. PPM	% Sat.	°C. Temp.	pH	D.O. PPM	% Sat.	°C. Temp.	pH	D.O. PPM	% Sat.
G-5B	5- 3-39	10:00AM	0	0	22	-	8.0	10.9		10.0	8.0	10.8	95.3	10.0	8.0	10.6	93.5
■	5-12-39	1:45PM	0	0	24	13.5	8.2	11.0	100.5	12.5	8.1	10.6	99.0	12.5	8.1	10.4	96.7
■	5-18-39	7:15AM	0	0	25	12.0	8.1	10.6	99.0	12.0	8.0	10.6	98.0	12.0	8.1	10.3	95.0
■	5-25-39	7:15AM	0	0	16	14.0	8.2	9.9	95.5					14.0	8.2	10.0	96.5
■	6- 1-39	5:00PM	-	-	28	18.0	8.2	9.4	96.5	13.0	8.2	9.3	97.5	16.0	8.1	7.3	73.4
G-6	11-23-38	2:00PM	-	-	30	2.5	7.9	12.[illegible]	92.4	2.5				2.5	7.0	12.3	92.4
■	2- 7-39	10:30AM	15	1	31	-	7.6	11.2		-	7.5	9.2		-	7.5	6.6	
■	2-15-39	11:30AM	16	-	30	-	7.1	3.1		-	7.0	2.9		-	7.0	2.0	
■	2-21-39	PM	23	-	30	-	7.2	5.4		-	7.2	3.6		-	7.2	4.4	
■	3- 1-39	1:45PM	20	Dr.	32	-	7.2	5.5						-	7.1	4.5	
■	3- 7-39	12:50PM	19	7	31	-	7.3	6.3		-	7.2	4.6		-	7.2	5.7	
■	3-13-39	2:45PM	18	½-2	32	-	7.2	7.4		-	7.3	7.5		-	7.3	6.7	
■	3-20-39	3:30PM	22	0	32	-	7.1	7.9		-	-	-		-	7.1	6.6	
G-6A	2- 7-39	3:30PM	17	1	32	-	7.3	10.3		-	7.2	7.7		-	7.1	5.3	
■	2-13-39	10:00AM	18	1	32	-	7.3	10.0		-	7.3	10.0		-	7.1	5.5	
■	2-21-39	PM	20	0-1	34	-	7.2	6.0		-	7.1	6.4		-	7.2	6.0	
■	3- 1-39	1:15PM	24	Dr.	32	-	7.2	3.7		-	-	-		-	7.2	7.3	
■	3- 7-39	Noon	21	7	35	-	7.5	5.6		-	7.3	9.4		-	7.3	6.0	
■	3-14-39	2:45PM	22	2-3	36	-	7.5	11.2		-	7.4	9.0		-	7.3	3.4	
■	3-20-39	3:00PM	24	0	35	-	7.1	9.6		-	-	-		-	7.1	7.7	
G-7	11-23-38	2:40PM	-	-	35	4.5	7.9	12.7	96.[illegible]	4.25				4.25	8.0	13.1	100.0
■	2-15-39	10:30AM	18	0	33	-	7.4	11.0		-	7.4	11.5		-	7.3	8.2	
■	2-21-39	PM	20	0-1	35	-	7.4	11.0		-	7.4	10.0		-	7.3	11.6	
■	3- 1-39	1:00PM	15	Dr.	34	-	7.2	8.5		-	7.2	8.7		-	7.2	8.0	
■	3- 7-39	11:40AM	19	7	34	-	7.5	9.6		-	7.5	9.1		-	7.3	8.5	
■	3-14-39	3:00PM	21	2-3	37	-	7.5	11.9		-	7.5	11.5		-	7.4	9.3	
■	3-20-39	2:45PM	22	0	36	-	7.3	11.1		-	7.2	11.1		-	7.2	9.7	
■	5- 3-39	11:15AM	0	0	36	9.0	8.1	11.2	96.7	9.0	8.0	11.4	98.5	8.5	8.0	10.6	
■	5-18-39	8:45AM	0	0	34	12.0	8.1	10.1	93.0	12.0	8.1	10.0	92.4	12.0	8.1	10.0	
■	5-26-39	2:20PM	0	0	33	15.0	8.3	10.8	100.6	14.0	8.3	10.4	100.00	14.0	8.3	10.3	100.0
G-7A	3-21-39	1:15PM	23	0-1	31	-	7.6	12.2						-	7.6	12.1	
G-8	11-23-38	3:40PM	-	-	26	4.0	7.9	13.1	100.0	4.0	-	-		4.0	7.9	13.1	100.0
G-8A	3-21-39	2:05PM	24	0-1	18	-	7.6	12.4						-	7.3	12.4	
G-9	11-23-38	-	-	-	26	4.0	7.3	13.4	100.2	3.5	-	-		3.5	7.9	13.5	100.2
■	2-16-39	-	16	1	25	-	7.2	8.0		-	7.2	7.9		-	7.2	7.2	
■	2-22-39	-	20	-	26	-	7.2	8.9		-	7.3	8.9		-	7.2	8.4	
■	3- 1-39	12:45PM	15	1-2	25	-	7.4	8.7		-	7.4	8.2		-	7.5	8.0	
■	3- 6-39	2:45PM	20	5-10	26	-	-	8.4		-	-	9.8		-	-	7.4	
■	3-13-39	11:45AM	20	½-2	26	-	7.3	7.6		-	7.3	7.3		-	7.3	6.7	
■	3-20-39	10:45AM	22	0	27	-	7.1	6.3		-	-	-		-	7.2	7.2	
■	4-25-39	1:15PM	0	0	26	3.2	7.4	10.6	81.6	3.1	7.4	10.9	81.5	3.0	7.3	10.8	80.2
■	5- 3-39	1:00PM	0	0	25	10.5	8.2	11.1	99.2	10.0	8.1	11.0	97.0	10.0	8.0	10.5	92.5
■	5-12-39	10:30AM	0	0	29	11.5	8.0	10.8	98.5	10.5	8.0	10.9	97.3	10.0	8.0	10.7	94.5
■	5-18-39	9:45AM	0	0	27	13.0	8.1	9.5	89.6	13.0	8.1	9.3	97.7	12.5	8.1	9.3	96.3
■	5-26-39	12:45PM	0	0	29	16.0	8.2	9.9	99.5	15.0	8.1	9.8	96.5	14.0	8.1	9.8	94.5

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(Cont.)

Station	Date	Time	Ice (In.)	Snow (In.)	Total Depth (Ft.)	Sampling Depths 3 Feet °C. Temp.	pH	D.O. PPM	% Sat.	Middle °C. Temp.	pH,	D.O. PPM	% Sat.	1 Foot above Bottom °C. Temp.	pH	D.O. PPM	% Sat.
G-10	11-25-38	9:25AM	½-1	—	13	0.0	7.7	12.6	86.0	1.0	—	—		1.0	7.7	12.5	87.7
"	2-6-39	Noon	15	½	15	—	7.2	10.0						—	7.4	9.5	
"	2-13-39	11:15AM	—	—	13	—	7.3	10.2						—	7.3	Broke	
"	2-20-39	PM	14	0-1	15	—	7.6	9.0						—	7.6	8.9	
"	2-27-39	10:35AM	14	0-1	14	—	7.3	11.3						—	7.3	10.9	
"	3-8-39	12:35PM	20	7	16	—	7.4	9.1						—	7.4	9.1	
"	3-14-39	10:50AM	20	2-3	16	—	7.4	7.4						—	7.3	7.6	
"	3-21-39	10:45AM	19	0	16	—	6.1	5.8						—	7.1	5.9	
G-11	11-25-38	9:45AM	—	—	20	0.25	7.7	12.7	87.5	0.25	—	—		0.25	7.7	12.7	87.5
G-12	11-25-38	10:50AM	—	—	6	0.0	7.7	13.7	94.3								
"	2-3-39	11:30AM			3.5	—	7.2	7.5									
G-12B	1-19-39	PM	• 1	—	4	0.9	7.0	4.4	30.9								
"	1-26-39	4:30PM	5	0	4	—	7.2	7.4									
"	2-3-39	Noon	2	0	4	—	—	7.5									
"	2-17-39	2:00PM	3	0-2	3.5	—	7.3	8.4									
"	2-21-39	AM	4	0-1	3.5	—	7.5	9.0									
"	3-9-39	11:45AM	1	1-6	3	—	7.4	6.7									
"	3-22-39	9:00AM	1	0	4	—	7.1	5.4									
			(• - Soft ice)														
G-12H	1-20-39	2:35PM	1	—	5	0.6	7.0	6.4	44.4								
"	5-10-39	3:30PM	—	—	5	—	8.1	10.0									
"	5-25-39	2:00PM	—	—	5	17.0	8.0	8.3	95.3								
G-12Q	2-3-39	1:00PM	14	1	10	—	7.3	9.6						—	7.2	7.3	
"	2-17-39	2:30PM	14	0-2	17	—	7.3	9.9		—	7.2	8.2		—	7.2	9.2	
"	2-21-39	AM	18	0-1	13	—	7.4	3.6		—	7.3	7.5		—	7.3	9.8	
"	3-9-39	Noon	26	1-6	10	—	7.4	8.7						—	7.4	6.0	
"	3-14-39	2:00PM	18	2-3	11.5	—	7.4	7.1						—	7.5	5.6	
"	3-22-39	10:45AM	19	0	12	—	7.1	5.6						—	7.1	4.7	
"	5-15-39	3:10PM	—	—	12	—	8.1	10.7						—	8.1	8.8	
G-13	11-25-38	11:45AM	—	—	3	0.25	8.1	15.1	100.4								
G-13A	1-13-39	2:30PM	11	3	12	0.4	7.6	12.6	87.5	0.4	—	—		0.6	7.6	12.2	84.5
"	1-23-39	2:20PM	13	1	19	0.4	7.3	10.5	73.0	—	7.0	6.2		0.4	7.0	6.5	45.0
"	1-27-39	4:15PM	14	3	19	—	7.3	6.0		—	7.3	5.8		—	7.2	5.5	
"	2-3-39	1:30PM	14	½	19	—	7.2	3.6		—	—	3.4		—	7.2	4.8	
"	2-7-39	3:45PM	16	1	19	—	—	3.0						—	—	3.3	
"	2-15-39	3:00PM	15	—	19	—	7.0	2.7						—	7.0	2.6	
"	2-22-39	1:35PM	19	Tr.	19	—	7.1	3.6						—	7.1	3.8	
"	3-1-39	3:45PM	14	1-2	19	—	7.5	5.8						—	7.4	6.0	
"	3-6-39	3:30PM	16	5-10	21	—	—	6.1				—		—	—	5.6	
"	3-13-39	1:15PM	20	½-2	17	—	7.2	4.9						—	7.2	4.4	
"	3-20-39	11:50AM	22	0	21	—	7.0	3.0						—	7.0	4.0	
G-13B	2-7-39	1:10PM	15	1	26	—	7.2	2.0		—	7.2	2.4		—	7.0	3.1	
"	2-15-39	2:30PM	15	—	25	—	7.3	5.0						—	7.1	4.2	
"	2-22-39	2:00PM	13	—	26	—	7.2	5.5						—	7.1	4.8	
"	3-3-39	12:55PM	23	2	26	—	7.2	8.2		—	7.2	7.9		—	7.2	6.6	
"	3-6-39	4:05PM	20	5-10	25	—	—	7.9						—	—	6.2	

(CONT.)

STATION	DATE	TIME	ICE (IN.)	SNOW (IN.)	TOTAL DEPTH (FT.)	SAMPLING DEPTHS											
						3 FEET				MIDDLE				1 FOOT ABOVE BOTTOM			
						°C. TEMP.	PH	D.O.	% SAT.	°C. TEMP.	PH	D.O. PPM	% SAT.	°C. TEMP.	pH	D.O. PPM	% SAT.
G-13B	3-13-39	1:30PM	20	½-2	27	-	7.2	6.8		-	7.2	6.7		-	7.2	4.6	
■	3-20-39	12:30PM	20	0	28	-	7.1	5.7		-	7.1			-	7.1	5.7	
G-14	11-25-38	12:05PM	-	-	21	1.0	7.9	13.5	94.8	1.0	-	-		1.0	7.7	13.4	94.2
■	2-8-39	1:30PM	12	1	20	-	7.1	3.9		-	7.0	3.3		-	7.0	3.7	
■	2-14-39	PM	12	-	21	-	7.1	4.3						-	7.1	4.3	
■	2-21-39	PM	12	1	21	-	7.3	5.0						-	7.2	5.1	
■	3-4-39	2:45PM	12	1-2	23	-	7.4	7.4						-	7.4	7.9	
■	3-6-39	1:00PM	13	5-10	21	-	-	5.7						-	-	5.0	
■	3-13-39	1:00PM	20	1-2	24	-	7.3	4.2						-	7.3	4.2	
■	3-20-39	11:30AM	-	-	23	-	7.1	3.9		-	7.1	3.8		-	7.1	3.9	
G-14A	2-7-39	12:30PM	13	3	23	-	7.1	5.2		-	7.1	5.2		-	7.0	4.9	
■	2-15-39	4:00PM	18	-	24	-	7.2	6.3						-	7.2	5.3	
■	2-22-39	1:12PM	19	-	23	-	7.2	7.5						-	7.2	7.4	
■	3-1-39	2:00PM	18	1-2	23	-	7.3	6.9						-	7.4	8.3	
■	3-6-39	1:40PM	14	5-10	24	-	-	7.1						-	-	6.9	
■	3-13-39	12:30PM	20	½-2	24	-	7.3	7.3		-	7.3	7.2		-	7.3	6.5	
■	3-20-39	11:15AM	20	0	25	-	7.1	5.1		-	7.1	-		-	7.1	5.2	
■	4-25-39	2:30PM	0	0	25	4.2	7.5	12.1	92.7	4.2	7.5	12.1	92.7	4.0	7.5	[illegible]	91.4
■	5-3-39	2:00PM	0	0	23	11.0	8.2	11.3	100.2	11.0	8.1	11.0	93.5	11.0	8.1	[illegible]	91.2
■	5-11-39	3:00PM	0	0	25	11.5	8.1	10.7	97.5	11.0	8.1	10.5	94.7	10.5	8.1	10.4	92.7
■	5-18-39	10:45AM	0	0	25	14.0	8.1	9.7	93.6	14.0	8.1	8.9	86.0	13.5	8.1	9.0	86.0
■	5-26-39	12:15PM	0	0	25	17.0	8.1	8.5	87.3	16.0	8.1	8.7	87.5	16.0	7.1	8.5	85.5
■	6-1-39	3:30PM	-	-	27	20.0	8.2	10.0	100.9	19.5	8.2	10.0	100.8	17.0	8.1	7.6	78.0
G-15	11-25-38	12:35PM	-	-	24	1.5	8.1	13.8	98.3	1.5	-	-		1.25	8.1	13.6	96.3
G-15A	2-8-39	1:50PM	16	1	23	-	7.1	6.1		-	7.2	6.2		-	7.2	5.9	
■	2-15-39	3:30PM	18	-	24	-	7.2	7.8						-	7.2	7.2	
■	2-22-39	12:45PM	20	-	27	-	7.3	9.0						-	7.3	8.7	
■	3-1-39	1:30PM	18	1-2	24	-	7.3	8.8						-	7.4	8.9	
■	3-6-39	2:15PM	18	5-10	25	-	-	8.1						-	-	7.5	
■	3-13-39	Noon	24	½-2	25	-	7.3	8.4						-	7.3	7.2	
■	3-20-39	11:00AM	22	0	27	-	7.1	6.7		-	7.2	6.7		-	7.1	6.9	
G-16	11-25-38	1:10PM	-	-	25	2.0	8.1	13.3	99.7	2.0	-	-		2.0	8.1	13.7	99.
G-17	11-25-38	2:00PM	-	-	27	1.0	8.1	13.9	97.5	1.0	-	-		1.0	8.1	13.8	
■	1-21-39	1:30PM	15	1	29	0.4	7.3	7.4	51.3	0.4	7.2	5.6		1.0	7.2	4.0	
■	2-15-39	1:00PM	16½	1	27	-	7.3	10.7		-	7.3	10.7		-	7.3	10.1	
■	2-21-39	PM	16	0-1	27	-	7.5	10.2		-	7.5	10.2		-	7.3	9.5	
■	3-1-39	11:50AM	24	1-2	25	-	7.5	9.7		-	7.4	9.6		-	7.6	9.7	
■	3-6-39	11:50AM	18	5-10	26	-	-	9.4		-	-	9.0		-	-	8.9	
■	3-13-39	11:00AM	24	½-2	27	-	7.3	8.2		-	7.3	-		-	7.3	7.6	
■	3-20-39	10:15AM	24	0	28	-	7.1	7.3		-	7.2	7.6		-	7.2	7.9	
■	5-4-39	11:00AM	0	0	27	10.0	8.0	10.9	96.0	-	-	-		9.5	8.0	11.0	
■	5-11-39	Noon	-	-	30	11.0	8.1	10.6	95.6	-	-	-		10.5	8.1	10.6	
■	5-18-39	12:15PM	0	0	30	13.5	8.1	10.6	100.1	13.0	8.1	10.0		13.0	8.1	9.9	
■	5-26-39	10:15AM	0	0	29	16.5	8.0	8.2	83.1	15.5	8.1	8.5		15.5	7.9	8.8	
■	6-1-39	1:30PM	-	-	30	19.5	8.1	9.7	100.5	18.5	8.1	9.5		17.0	8.0	6.9	

(Cont.)

Station	Date	Time	Ice (In.)	Snow (In.)	Total Depth (Ft.)	Sampling Depths: 3 Feet				Middle				1 Foot above bottom			
						°C. Temp.	pH	D.O. PPM	% Sat.	°C. Temp.	pH	D.O. PPM	% Sat.	°C. Temp.	pH	D.O. PPM	Sat.
G-18	11-25-38	3:10PM	-	-	27	0.0	7.7	12.4	84.7	0.25	-	-		0.25	7.7	11.8	81.2
•	1-24-39	2:00PM	8	2	27	-	7.4	12.5						-	7.4	13.2	
•	5-19-39	4:00PM	-	-	30	-	8.2	9.2		-	8.2	9.1		-	8.2	9.2	
•	5-26-39	8:00AM	-	-	28	16.5	7.6	6.3	64.0	16.5	7.7	6.6	67.0	16.5	7.7	6.5	66.0
•	6- 1-39	11:45AM	-	-	30	20.0	8.1	8.7	94.8	20.0	8.1	8.4	91.5	18.5	7.7	4.3	45.6
G-18A	1-24-39	1:00PM	11	2	14	-	7.4	12.5						-	Broke	-	
G-19	1-20-39	4:00PM	10	2	12	0.3	7.4	11.1	76.2	0.3	7.3	10.8	74.5	0.2	7.1	6.3	43.4
•	1-25- 39	2:30PM	13	2	12	0.0	7.3	11.3	77.6	0.0	7.3	10.3	73.7	0.0	7.3	10.7	73.6
•	2-13-39	4:35PM	-	-	12	-	7.4	11.9		-	7.3	12.4		-	7.3	11.5	
•	2-21-39	AM	22	1	12	-	7.5	11.3		-	7.6	9.3		-	7.5	11.2	
•	2-27-39	3:20PM	14	1	-	-	7.4	11.3						-	7.3	10.3	
•	3- 8-39	1:15PM	24	1-4	10½	-	7.5	10.1						-	7.5	8.9	
•	3-14-39	1:35PM	24	2-3	11	-	7.5	9.5						-	7.5	8.9	
•	3-22-39	11:30AM	19	0	12	-	7.2	9.4						-	7.1	8.9	
•	4- 3-39	3:00PM	0	0	11	4.2	7.4	7.9	60.5	4.4	7.4	7.9	61.0	4.2	7.4	8.1	62.0
•	5- 4-39	2:15PM	0	0	11	13.5	8.1	9.5	90.6					13.0	8.1	9.5	89.6
•	5-11-39	10:00AM	0	0	11	15.0	7.9	6.2	61.0					14.5	7.8	6.2	60.5
•	5-18-39	2:45PM	0	0	12	16.0	7.4	6.0	60.2					14.5	7.5	4.0	39.0
•	5-19-39	2:50PM	0	0	14	-	8.1	9.9						-	8.1	8.6	
•	5-25-39	2:00PM	0	0	12	16.0	-	7.1	71.4					16.0	-	6.9	60.4
•	6- 1-39	10:00AM	-	-	13	22.0	7.7	5.4	61.1					20.5	7.6	3.3	37.0
G-19A	2- 6-39	3:00PM	15	1	10	-	7.3	11.[illegible]						-	7.3	8.7	
•	5-25-39	2:35PM	-	-	14	16.5		7.6	77.0	-	7.8	-		16.0	-	7.5	75.4
•	6- 1-39	10:30AM	-	-	14	21.5	7.8	7.1	79.3					21.0	-	5.2	69.0
G-20	1-23-39	4:30PM	10	2	12	0.3	7.4	11.1	76.4	0.2	7.3	10.9	74.5	0.2	7.1	6.3	43.2
•	1-24-39	3:00PM	-	-	10½	0.0	7.3	11.1	76.0					0.0	7.2	9.6	66.0
G-21	1-21-39	2:00PM	10	2	23	0.4	7.0	5.3	36.7	0.1	7.3	7.5	52.0	0.8	7.2	4.3	30.0
•	1-27-39	3:00PM	12	2	22	-	7.2	6.5		-	7.3	6.5		-	7.2	8.3	
•	2- 3-39	2:30PM	15	1	22	-	7.3	6.4		-	7.3	6.7		-	7.3	6.3	
•	2- 7-39	2:00PM	15	1	21	-	7.5	7.9		-	7.4	7.5		-	7.5	7.2	
•	2-14-39	AM	22	-	22	-	7.3	8.5		-	7.3	8.7		-	7.3	7.9	
•	2-21-39	PM	12	0-1	21	-	7.4	9.1		-	7.4	8.9		-	7.3	8.9	
•	3- 1-39	11:25AM	14	1-2	20½	-	7.5	9.8		-	7.5	9.5		-	7.3	8.7	
•	3- 8-39	2:40PM	13	7	23	-	7.4	7.4		-	7.4	7.3		-	7.4	6.7	
•	3-13-39	10:45AM	18	½-2	21½	-	7.3	6.5		-	7.3	6.6		-	7.2	6.4	
•	3-20-39	9:50AM	21	0	23	-	7.1	5.9		-	7.1	5.8		-	7.1	5.4	
G-22	1-21-39	11:30AM	9	2½	15	0.4	7.0	4.1	28.5					0.6	7.0	5.0	41.0
•	1-27-39	2:30PM	10	2	14	-	7.1	4.1						-	7.1	3.6	
•	2- 3-39	2:00PM	13	½	14	-	7.1	5.6						-	7.2	6.0	
•	2- 7-39	1:00PM	14	1	14	-	7.4	4.6						-	7.2	4.2	
•	2-14-39	PM	14	0-1	14	-	7.1	6.5						-	7.1	5.4	
•	2-21-39	Noon	17	0-1	12	-	7.5	7.2						-	7.4	7.0	
•	3- 1-39	10:30AM	16	1-2	13	-	7.3	6.6						-	7.3	6.4	
•	3- 6-39	10:30AM	14	5-10	13¾	-	-	5.7						-	-	5.6	
•	3-13-39	10:00AM	24	½-2	14½	-	7.2	4.7						-	7.3	4.4	
•	3-20-39	9:30AM	10	0	15	-	7.1	3.3						-	7.1	4.8	
•	5- 4-39	9:[illegible]	0	0	15	13.0	8.2	10.2	96.4	12.5	-	-	-	12.5	8.2	10.1	94.0
•	5-11-39	2:[illegible]	0	0	15	14.0	8.1	9.7	93.5					13.5	8.1	9.4	39.7

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(Cont.)

Station	Date	Time	Ice (In.)	Snow (In.)	Total Depth (Ft.)	Sampling Depths											
						3 Feet				Middle				1 Foot above bottom			
						°C. Temp.	pH	D.O. PPM	% Sat.	°C. Temp.	pH	D.O. PPM	% Sat.	°C. Temp.	pH	D.O. PPM	% Sat.
G-22	5-18-39	11:30AM	0	0	18	14.0	8.2	11.1	100.7					13.0	8.2	9.8	92.5
"	5-26-39	11:00AM	0	0	17	17.0	8.1	9.3	95.7					16.0	8.1	8.7	87.5
"	6- 1-39	2:20PM	-	-	15	20.0	8.1	8.6	93.8					18.5	8.0	6.9	73.3
G-22A	2- 3-39	3:30PM	12	1	12									-	7.3	5.5	
"	2- 7-39	Noon	12	0-1	12¼	-	7.3	6.6						-	7.4	5.7	
"	2-14-39	PM	14	0-1	12¾	-	7.1	6.5						-	7.1	4.9	
"	2-22-39	5:30PM	24	Dr.	12¾	-	7.3	7.7						-	7.2	7.2	
"	3- 1-39	10:10AM	15	1-2	11¾	-	7.4	6.4						-	7.4	6.3	
"	3- 6-39	10:15AM	12	5-10	11½	-	-	5.7						-	-	5.6	
"	3-13-39	10:00AM	24	½-2	12	-	7.2	4.6						-	7.3	4.5	
"	3-20-39	9:15AM	22	½-1	13	-	7.1	5.0						-	7.0	4.8	
G-23	1-21-39	3:50PM	10	2	18	0.4	7.1	5.5	38.0					0.6	7.1	5.4	37.4
G-24	1-21-39	4:15PM	12	2	16	0.4	7.2	7.1	49.2					0.6	7.2	6.8	47.2
"	1-27-39	3:30PM	12	4	17	-	7.0	3.5						-	7.1	3.3	
"	2- 3-39	3:00PM	18	1	17	-	7.2	4.2						-	7.2	4.4	
"	2- 7-39	3:00PM	14	1	17	-	-	5.7						-	-	5.4	
"	2-14-39	PM	16	½	18	-	7.1	5.1						-	7.1	5.1	
"	2-21-39	PM	16	0-1	17	-	7.4	6.5						-	7.3	6.5	
"	3- 1-39	10:50AM	18	1-2	16	-	7.4	5.5						-	7.3	5.6	
"	3- 6-39	10:55AM	15	5-10	17	-	-	4.8						-	-	4.6	
"	3-13-39	10:30AM	18	½-2	18	-	7.2	4.3		-	7.3	4.7		-	7.2	4.6	
"	3-20-39	9:40AM	16	0	19	-	7.0	3.7		-	-	-		-	7.0	4.7	
G-25	1-24-39	3:00PM	10	2	10½	0.0	7.2	9.6	65.7					0.6	7.2	4.7	32.6
"	2- 6-39	11:00AM	18	1	10	-	7.4	10.8						-	7.1	6.0	
"	2-16-39	10:15AM	15	1	10	-	7.4	11.6						-	7.2	7.3	
"	2-22-39	10:00AM	19	Dr.	10	-	7.3	11.1						-	7.2	8.2	
"	2-27-39	3:15PM	14	½-Dr	10½	-	7.4	11.5						-	7.3	6.8	
"	3- 8-39	3:40PM	20	7	12	-	7.4	10.2						-	7.4	7.9	
"	3-14-39	9:15AM	20	4-5	12	-	7.5	9.5						-	7.3	6.2	
"	3-21-39	2:20PM	20	0	12	-	7.1	7.2						-	7.2	6.4	
"	5-26-39	7:30AM	-	-	12	16.5	7.3	6.5	66.0					16.0	7.6	6.5	66.0
G-26	1-26-39	2:00PM	8	3	18	-	7.3	6.2						-	7.3	6.5	
"	2-22-39	11:20AM	15½	-	16	-	7.2	8.5						-	7.2	7.6	
"	3- 9-39	2:00PM	19	7	18	-	7.4	7.8						-	7.3	9.7	
"	3-14-39	1:00PM	18	4-5	19	-	7.4	7.5						-	7.4	6.7	
"	3-21-39	1:20PM	16	0	18½	-	7.1	6.3						-	7.1	6.6	
"	5- 4-39	Noon	0	0	18	11.5	8.2	10.7	97.5					11.0	8.2	10.9	98.5
"	5-11-39	1:00PM	0	0	18	11.5	8.1	10.6	96.3					11.0	8.1	10.7	96.5
"	5-18-39	1:00PM	0	0	18	14.0	8.1	10.3	99.3					13.0	8.1	10.1	95.[illegible]
"	5-26-39	9:30AM	0	0	18	16.0	8.2	9.8	98.5					16.0	8.2	9.5	95.4
G-26A	2- 3-39	Noon	15	2	22	-	7.3	9.9						-	7.3	10.0	
"	2-16-39	11:55AM	17	1	22¼	-	7.3	10.0						-	7.3	9.0	
"	2-22-39	11:00AM	15½	Dr.	22½	-	7.4	10.5						-	7.2	10.3	
"	3- 9-39	1:40PM	18	7	24	-	7.4	8.8						-	7.4	8.5	
"	3-14-39	12:45PM	18	4-5	24	-	7.4	7.7						-	7.4	7.4	
"	3-21-39	1:00PM	19	0	24½	-	7.1	7.5						-	7.1	7.1	

(CONT.)

STATION	DATE	TIME	ICE (IN.)	SNOW (IN.)	TOTAL DEPTH (FT.)	SAMPLING DEPTHS											
						3 FEET				MIDDLE				1 FOOT ABOVE BOTTOM			
						°C. TEMP.	PH	D.O.	% SAT.	°C. TEMP.	PH	D.O. PPM	% SAT.	°C. TEMP.	PH	D.O. PPM	% SAT.
G-27	1-26-39	3:15PM	15	–	4	–	7.1	10.1									
▪	3- 8-39	4:00PM	25	7	4½	–	7.4	8.3									
G-27A	3-14-39	AM	25	2-3	10	–	7.3	8.2						–	7.3	7.5	
G-28	1-27-39	NOON	4	1	3	–	7.3	9.3									
▪	2- 3-39	5:00PM	9	–	1½	–	–	9.6									
▪	2- 6-39	10:00AM	9	½	3	–	7.6	9.1									
▪	2-13-39	10:00AM	–	–	3	–	7.4	10.3									
▪	2-20-39	PM	10	½	3	–	7.6	9.6									
▪	2-27-39	9:30AM	12	0-1	3	–	7.3	9.6									
▪	3- 8-39	9:45AM	18	7	2 3/4	–	7.3	7.7									
▪	3-14-39	9:40AM	20	2-3	3	–	7.5	7.3									
▪	3-21-39	10:00AM	17	0	2½	–	7.1	6.5									
G-29	1-27-39	12:30PM	10	2	11½	–	7.4	11.7						–	7.3	11.7	
▪	2- 3-39	4:10PM	15	–	9	–	–	11.7									
▪	2-13-39	9:25AM	–	–	11	–	7.8	11.3						–	7.8	11.0	
▪	2-20-39	PM	10	0-1	10	–	7.6	12.1						–	7.6	11.4	
▪	2-27-39	9:45AM	18	0-1	10	–	7.3	10.5						–	7.3	11.5	
▪	3- 8-39	9:30AM	18	7	11	–	7.4	9.6						–	7.4	9.5	
▪	3-14-39	9:25AM	15	2-3	10	–	7.5	8.9						–	7.5	9.1	
▪	3-21-39	9:45AM	18	0	12	–	7.2	9.0						–	7.2	10.1	
G-29A	5-13-39	4:25PM	–	–	33	–	8.0	7.9		–	6.0	7.6		–	8.0	7.9	
▪	5-25-39	4:00PM	–	–	30	17.0	7.8	5.0	51.4	17.0	–	5.3	54.5	17.0	–	4.9	53.4
▪	6- 1-39	11:15AM	–	–	32	21.0	7.7	5.9	65.6	20.0	7.7	4.9	52.3	18.5	7.6	3.8	40.2
G-30	2- 6-39	10:30AM	14	½	6	--	7.6	10.2									
▪	2-13-39	10:45AM	–	–	9	–	7.4	10.3									
▪	2-20-39	PM	12	0-1	6	–	7.4	10.1									
▪	2-27-39	10:00AM	24	0-1	8	–	7.3	9.5									
▪	3- 8-39	10:05AM	21	7	10	–	7.4	8.1						–	7.3	7.8	
▪	3-14-39	9:50AM	18	2-3	9	–	7.4	6.6						–	7.5	6.6	
▪	3-21-39	10:10AM	22	0	10	–	7.1	6.0						–	7.2	5.9	
G-31	2- 6-39	1:15PM	12	1	21	–	–	9.5		–	–	9.8		–	7.4	8.8	
▪	2-13-39	12:50PM	–	–	21	–	7.4	7.5		–	7.4	10.5		–	7.4	10.1	
▪	2-20-39	PM	14	0-1	21	–	7.5	9.6		–		9.6		–	7.5	10.2	
▪	2-27-39	11:15AM	14	0-1	22	–	7.4	11.6		–	7.3	10.8		–	7.3	10.8	
▪	3- 8-39	11:40AM	20	7	24	–	7.4	8.8		–	7.4	8.7		–	7.4	8.3	
▪	3-14-39	11:35AM	21	3-4	24		7.4	8.3		–	7.4	8.6		–	7.4	8.7	
▪	3-21-39	12:30PM	19	0	23	–	7.1	7.0		–	7.1	6.4		–	7.1	6.5	
G-31A	4-13-39	4:00PM	0	0	24	1.2	7.5	11.2	79.2	1.0	7.5	11.2	79.2	1.0	7.5	11.3	79.[illegible]
▪	5- 4-39	1:15PM	0	0	28	12.5	8.2	–		11.5	8.2	10.2	93.2	12.0	8.1	10.2	94.[illegible]
▪	5-11-39	11:00AM	0	0	22	12.0	8.1	10.0	92.3	–	–	–		11.5	8.1	10.0	
▪	5-19-39	1:45PM	0	0	30	15.0	8.2	10.1	99.5	14.0	9.2	10.0	96.3	14.0	9.2	9.9	96.5
▪	5-26-39	9:30AM	0	0	29	16.5	7.9	7.8	79.0	16.0	7.9	7.4	74.2	16.0	7.9	7.4	74.2
G-32	2- 6-39	2:00PM	14	1	15	–	–	7.1						–	7.4	7.5	
▪	2-13-39	1:25PM	–	–	15	–	7.3	8.1						–	7.3	7.6	
▪	2-20-39	PM	12	0-1	15	–	7.3	7.2						–	7.4	6.7	
▪	2-27-39	11:45AM	13	0-1	15	–	7.3	8.2						–	7.3	8.4	

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(Cont.)

Station	Date	Time	Ice (In.)	Snow (In.)	Total Depth (Ft.)	Sampling Depths 3 Feet °C. Temp.	pH	D.O. PPM	% Sat.	Middle °C. Temp.	pH	D.O. PPM	% Sat.	Foot above bottom °C. Temp.	pH	D.O. PPM	% Sat.
G-32	3- 8-39	11:20AM	18	7	17	-	7.4	5.1						-	7.3	5.1	
″	3-14-39	Noon	18	4-5	17½	-	7.3	5.2						-	7.3	5.5	
″	3-21-39	11:45AM	17	0	17	-	7.1	5.6						-	7.1	5.7	
G-33	2- 6-39	3:00PM	12	1	12	-	7.4	9.1						—	7.5	8.7	
″	2-13-39	2:00PM	-	-	12	-	7.3	8.7						-	7.3	9.2	
″	2-20-39	PM	12	0-1	12	-	7.4	7.2						-	7.4	8.5	
″	2-27-39	12:45PM	15	0-1	12	-	7.3	6.9						-	7.3	9.5	
″	3- 8-39	11:05AM	19	7	13	-	7.3	5.9						-	7.3	5.9	
″	3-14-39	10:25AM	18	2-3	13	-	7.5	6.3						-	7.5	6.7	
″	3-21-39	11:20AM	18	0	14	-	7.1	5.1						-	7.1	5.1	
G-34	2- 6-39	3:45PM	12	1	5	-	7.4	9.7									
″	2-13-39	2:30PM	-	-	5	-	7.3										
″	2-20-39	PM	14	0-1	5	-	7.4	9.4									
″	2-27-39	4:05PM	15	0-1	5	-	7.3	9.0									
″	3- 8-39	10:20AM	18	7	7	-	7.4	8.4									
″	3-14-39	10:55AM	15	2-3	6½	-	7.5	6.3									
″	3-21-39	10:30AM	20	0	6½	-	7.1	6.[illegible]									
G-35	2- 8-39	11:15AM	14	1	29½	-	7.5	8.4		-	7.3	6.7		-	7.4	4.3	
″	2-15-39	Noon	15	-	30	-	7.1	4.1		-	7.1	3.4		-	7.1	3.[illegible]	
″	2-22-39	2:45PM	19	Dr.	30	-	7.2	5.9		-	7.2	5.4		-	7.2	5.3	
″	3- 1-39	10:30AM	20	Dr.	29	-	7.1	6.8		-	7.1	-		-	7.1	7.1	
″	3- 7-39	1:10PM	20	7	30	-	7.3	7.8		-	7.3	8.0		-	7.3	6.6	
″	3-13-39	2:00PM	18	½- 2	30	-	7.3	8.1						-	7.3	6.7	
″	3-20-39	1:10PM	24	0	32	-	7.1	7.5						-	7.1	6.7	
G-36	2- 7-39	12:30PM	19	1	28	-	7.0	3.1		-	7.1	2.5		-	7.1	2.1	
″	2-15-39	12:45PM	16	-	29	-	7.1	4.7		-	7.1	5.1		-	7.1	4.5	
″	2-22-39	2:25PM	21	-	29½	-	7.2	7.0		-	7.2	6.3		-	7.2	5.6	
″	3- 1-39	11:00AM	20	Dr.	29	-	7.1	7.3		-	7.1	8.1		-	7.1	7.1	
″	3- 7-39	10:10AM	22	7	29	-	7.4	8.2		-	7.4	8.0		-	7.3	7.2	
″	3-13-39	1:45PM	16	½-2	30	-	7.3	7.1						-	7.3	7.1	
″	3-20-39	12:45PM	22	0	30	-	7.1	7.0		-	7.1	6.9		-	7.0	6.4	
G-37	2-15-39	1:15PM	18	-	30	-	7.2	6.5		-	7.2	6.1		—	7.1	4.9	
″	2-21-39	PM	22	0-1	31	-	7.2	6.2		-	7.2	6.4		-	7.2	5.7	
″	3- 1-39	11:30AM	25	Dr.	30	-	7.2	7.2		-	7.2	7.4		-	7.2	5.8	
″	3- 7-39	10:35AM	23	7	31	-	7.5	8.0		-	7.4	7.9		-	7.3	6.4	
″	3-14-39	2:30PM	25	4-5	32	-	7.3	8.2		-	7.3	8.2		-	7.3	6.5	
″	3-20-39	1:50PM	24	0	31	-	7.1	7.4		-	7.1	7.5		-	7.1	6.4	
G-38	2-15-39	1:45PM	15	½	31	-	7.3	8.1		-	7.2	8.2		-	7.2	8.0	
″	2-21-39	PM	22	1	31	-	7.3	9.9		-	7.3	8.4		-	7.2	8.2	
″	3- 1-39	Noon	24	Dr.	31	-	7.3	9.7		-	7.2	8.4		-	7.2	8.4	
″	3- 7-39	11:00AM	21	7	31	-	7.5	11.0		-	7.5	10.7		-	7.4	8.2	
″	3-14-39	2:10PM	22	4-5	33	-	7.5	11.8		-	7.5	12.2		-	7.5	9.5	
″	3-20-39	2:15PM	20	0	32	-	7.3	11.4		-	7.3	11.4		-	7.3	10.0	
G-38A	3-21-39	1:40PM	26	0-1	24	-	7.6	12.5						-	7.6	12.4	
G-39	2-16-39	3:10PM	18	1	38	-	7.5	12.7		-	7.4	11.6		-	7.2	7.6	
″	2-22-39	3:25PM	-	-	37	-	7.5	10.7		-	7.4	10.1		-	7.2	8.0	
″	3- 1-39	2:15PM	24	Dr.	39	-	7.3	10.[illegible]		-	7.2	9.6		-	7.2	9.2	

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(Cont.)

Station	Date	Time	Ice (In.)	Snow (In.)	Total Depth (Ft.)	Sampling Depths 3 Feet °C. Temp.	pH	D.O. PPM	% Sat.	Middle °C. Temp.	pH	D.O. PPM	% Sat.	1 Foot above Bottom °C. Temp.	pH	D.O. PPM	% Sat.
G-39	3- 7-39	2:40PM	20	7	39	-	7.2	5.4		-	7.2	5.6		-	7.2	6.0	
"	3-13-39	3:30PM	20	3	39	-	7.4	8.8		-	-	5.0		-	7.3	6.2	
"	3-21-39	11:35AM	28	0-1	39	-	7.4	9.3		-	7.4	8.8		-	7.4	8.7	
G-39A	3-21-39	12:45PM	24	0-1	38	-	7.5	11.5						-	7.5	11.0	
G-40	2-16-39	3:50PM	22	1	34	-	7.5	11.4		-	7.3	11.3		-	7.2	6.1	
"	2-22-39	4:00PM	21	Dr.	34	-	7.2	5.8		-	7.2	5.0		-	7.2	3.0	
"	3- 1-39	3:30PM	26	Dr.	35	-	7.1	5.2		-	7.1	4.3		-	7.1	3.9	
"	3- 7-39	2:15PM	19	7	34	-	7.3	4.9		-	7.2	5.3		-	7.2	3.8	
"	3-13-39	3:10PM	20	3	35	-	7.3	6.3		-	-	5.0		-	7.3	4.1	
"	3-21-39	10:40AM	25	0-1	34	-	7.3	5.8		-	7.3	5.5		-	7.3	5.2	
G-41	2-16-39	4:30PM	24	1	8,	-	7.4	10.0						-	7.4	10.2	
"	2-22-39	4:50PM	24	Dr.	7½	-	7.2	7.7						-	7.2	7.7	
"	3- 1-39	10:25AM	23	2	8	-	7.1	4.1						-	7.1	3.9	
"	3- 7-39	-	-	-	8	-	7.2	3.5						-	7.2	3.4	
"	3-13-39	2:50PM	20	3	8	-	7.3	3.7						-	7.3	3.6	
"	3-21-39	10:20AM	21	0-1	8	-	7.3	3.9						-	7.3	3.6	
G-42	3- 1-39	2:10PM	23	2	41	-	7.4	11.6		-	7.4	11.5		-	7.2	6.6	
"	3- 7-39	3:05PM	24	7	42	-	7.6	11.9						-	7.4	7.4	
"	3-13-39	1:25PM	25	3	42	-	7.5	10.4		-	-	7.7		-	7.4	7.2	
"	3-20-39	3:50PM	27	0-2	40	-	7.5	8.8		-	-	8.0		-	7.3	5.5	
G-42A	3-20-39	2:55PM	28	0-1	42	-	7.6	11.0						-	7.5	10.3	
G-43	3- 1-39	2:55PM	22	2	34	-	7.2	5.8		-	7.2	5.9		-	7.1	4.0	
"	3- 7-39	3:30PM	24	7	34	-	7.3	4.0		-	7.3	3.8		-	7.2	2.9	
"	3-13-39	1:55PM	23	3	34	-	7.3	3.7		-	-	4.6		-	7.3	3.6	
"	3-20-39	4:20PM	28	0-2	33	-	7.2	3.7		-	-	3.0		-	7.2	3.0	
G-44	3- 1-39	10:00AM	27	2	7	-	7.3	9.4									
"	3- 7-39	4:05PM	29	7	7	-	7.4	9.4									
"	3-13-39	2:35PM	27	3	5	-	-	7.4									
"	3-20-39	4:45PM	28	0-4	7	-	7.4	7.1									
G-45	3- 9-39	11:30AM	22	7	43	-	7.5	11.2		-	7.5	9.7		-	7.3	8.0	
"	3-13-39	1:05PM	22	3	45	-	7.3	9.0		-	-	7.8		-	7.3	5.4	
"	3-20-39	1:50PM	24	0-1	42	-	7.4	6.8		-	-	6.3		-	7.3	5.0	
G-45A	3-20-39	2:20PM	27	0-1	45	-	7.6	10.3						-	7.6	9.5	
G-46	3- 9-39	1:00PM	22	7	38	-	7.3	6.7		-	7.2	6.9		-	7.0	3.2	
"	3-13-39	12:35PM	21	3	38	-	7.3	6.8		-	-	6.6		-	7.2	3.6	
"	3-20-39	1:20PM	22	0-2	39	-	7.3	4.0		-	-	3.6		-	7.4	3.5	
G-47	3- 9-39	1:45PM	27	7	5	-	7.4	8.1									
"	3-13-39	11:40AM	24	3	5	-	7.5	7.9									
"	3-20-39	1:00PM	29	0-2	5	-	7.5	6.0									
G-48	3- 9-39	2:15PM	27	7	24	-	7.3	8.1						-	7.3	6.5	
"	3-13-39	10:30AM	24	3	24	-	7.3	7.5						-	7.3	6.0	
"	3-20-39	3:20PM	29	0-2	21	-	7.3	6.2						-	7.2	6.7	

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(CONT.)

STATION	DATE	TIME	ICE (IN.)	SNOW (IN.)	TOTAL DEPTH (FT.)	SAMPLING DEPTHS										
						3 FEET				MIDDLE				FOOT ABOVE		
						°C. TEMP.	PH	D.O. PPM	% SAT.	°C. TEMP.	PH	D.O. PPM	% SAT.	°C. TEMP.	PH	D.O. PPM
G-49	3- 9-39	2:45PM	-	-	42	-	7.5	10.1		-	7.4	9.9		-	7.2	3.7
"	3-13-39	10:45AM	26	3	42	-	7.4	9.1		-	-	9.0		-	7.2	3.6
"	3-20-39	11:35AM	27	0-2	44	-	7.5	9.2		-	-	9.0		-	7.4	6.0
G-50	3- 9-39	3:25PM	22	7	48	-	7.5	10.9		-	7.5	10.7		-	7.4	6.1
"	3-13-39	11:09AM	21	3	48	-	7.6	10.7		-	-	10.5		-	7.6	8.4
"	3-20-39	11:30AM	25	0-3	46	-	7.6	10.4		-	-	10.3		-	7.5	7.8
G-51	3-20-39	10:20AM	27	0-2	49½	-	7.5	11.0						-	7.7	10.7

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APPENDIX X.

CHEMICAL DATA
GREEN BAY
1955/1956

Appendix X.

CHEMICAL DETERMINATIONS GREEN BAY, 1955

Part 1 Inner Green Bay

Group 1. South of a generally East-West line through the Grassy Islands and extending south to the mouth of the Fox River

Position	Date	Depth, feet	Dissolved Oxygen, p.p.m.	Tempera- ture, °C.	Per Cent Saturated	Biochemical Oxygen Demand, p.p.m.	Total Alkalinity, p.p.m.	pH
1	6-16-55	26 Bottom	1.5	24.0	18	16.0	--	--
	6-16-55	10	0.7	21.5	8	18.5, 24.0	--	--
	6-16-55	3	1.7	20.0	19	15.5	--	--
8	8-17-55	9	0.3	27.0	4	--	--	--

Group 2. North of a generally East-West line through the Grassy Islands and south of a generally East-West line from the tip of Long Tail Point to Point Sable and including Long Tail Slough

Position	Date	Depth, feet	Dissolved Oxygen, p.p.m.	Tempera- ture, °C.	Per Cent Saturated	Biochemical Oxygen Demand, p.p.m.	Total Alkalinity, p.p.m.	pH
10	6-16-55	28 Bottom	1.9	20.0	21	11.5	--	--
	6-16-55	10	4.7	20.8	52	9.0	--	--
	6-16-55	3	6.3	22.5	72	11.0	--	--
	8-17-55	13	0.0	28.0	0	26.5	0+138	7.6
11	8-17-55	8	6.4	27.0	79	5.3	0+134	8.4
12	8-17-55	8	0.0	27.5	0	25.0	0+138	7.6
13	8-17-55	13	6.5	27.0	80	5.2	2+128	8.4
22	9-1-55	14	7.0	21.8	79	5.5	0+130	8.2
23	8-17-55	10	5.9	26.5	72	4.1	0+134	8.4

Appendix X.(Continued)

CHEMICAL DETERMINATIONS GREEN BAY, 1955

Part 1 Inner Green Bay

Group 2. North of a generally East-West line through the Grassy Islands and south of a generally East-West line from the tip of Long Tail Point to Point Sable and including Long Tail Slough (Continued)

Position	Date	Depth, feet	Dissolved Oxygen, p.p.m.	Tempera-ture, °C.	Per Cent Saturated	Biochemical Oxygen Demand, p.p.m.	Total Alkalinity, p.p.m.	pH
25	6-16-55	20	6.9	20.0	75	1.3	--	--
	6-16-55	10	8.9	18.8	95	1.4	--	--
	6-16-55	3	9.1	20.5	100	1.3	--	--

Part 2 Middle Green Bay

Group 1. Vicinity of the Navagational Channel

Position	Date	Depth, feet	Dissolved Oxygen, p.p.m.	Tempera-ture, °C.	Per Cent Saturated	Biochemical Oxygen Demand, p.p.m.	Total Alkalinity, p.p.m.	pH
29	9-1-55	21	5.7	21.0	64	2.2	0+134	8.3
31	6-6-55	15 Bottom	6.2	16.0	62	0.1	--	--
	6-6-55	3	7.8	18.5	82	0.1	--	--
35	9-1-55	20	6.6	22.1	75	3.9	T+126	8.4
36	9-1-55	20	6.6	22.8	76	3.3	T+126	8.4
37	7-18-55	19	7.3	22.0	82	2.3	T+122	8.4
38	7-18-55	15	7.2	21.8	81	2.0	--	--
39	7-18-55	15	8.0	21.6	90	2.2	0+120	8.3
	7-25-55	3	0.5	24.1	6	7.5	0+30	7.5

Appendix X. (Continued)

CHEMICAL DETERMINATIONS GREEN BAY, 1955

Part 2 Middle Green Bay

Group 2. Vicinity of the mouth of the Big Suamico River

Position	Date	Depth, feet	Dissolved Oxygen, p.p.m.	Tempera- ture, °C.	Per Cent Saturated	Biochemical Oxygen Demand, p.p.m.	Total Alkalinity, p.p.m.	pH
44	8-30-55	10 Bottom	7.3	20.0	80	--	T+128	8.4
	8-30-55	Surface	7.8	20.5	86	--	T+128	8.4
Group 3. Vicinity of Little Tail Point								
46	6-16-55	5 Mid-depth	8.1	19.0	87	0.8	--	--
48	6-6-55	13	6.2	17.0	64	2.1	--	--
	6-6-55	3	8.9	20.0	97	3.0	--	--
	6-16-55	6 Mid-depth	8.7	19.8	95	1.3	--	--
49	6-6-55	13 Bottom	6.9	18.5	73	1.1	--	--
	6-6-55	3	8.7	19.0	93	2.1		
	6-16-55	16 Bottom	7.7	20.0	84	0.7	--	--
	6-16-55	3	9.1	19.0	97	1.0	--	--
Group 4 Vicinity of the Entrance Light								
57	6-16-55	25 Bottom	9.6	18.8	103	1.2	--	--
	6-16-55	20	9.0	19.5	97	1.9	--	--
	6-16-55	15	8.5	20.5	94	0.3	--	--
	6-16-55	10	7.5	20.5	83	1.5	--	--
	6-16-55	3	6.4	22.5	73	1.7	--	--
58	9-1-55	23	6.5	26.5	80	1.0	0+124	--
59	8-25-55	24	6.4	26.5	79	1.0	0+124	

Appendix X. (Continued)

CHEMICAL DETERMINATIONS GREEN BAY, 1955

Part 2 Middle Green Bay

Group 5 Point Comfort to Schumakers Point East Shore

Position	Date	Depth, feet	Dissolved Oxygen, p.p.m.	Tempera- ture, °C.	Per Cent Saturated	Biochemical Oxygen Demand, p.p.m.	Total Alkalinity, p.p.m.	pH
61	6-6-55	15 Bottom	6.7	16.5	68	0.1	—	—
	6-6-55	3	8.9	18.5	94	0.1	—	—
63	8-30-55	20	7.3	24.6	87	2.4	—	—
	8-30-55	10	8.2	24.3	97	2.3	—	—
	8-30-55	Surface	8.4	24.0	98	2.6	T+132	8.2

Part 3 Outer Green Bay

Group 3 Schumakers Point to Sherwood Point

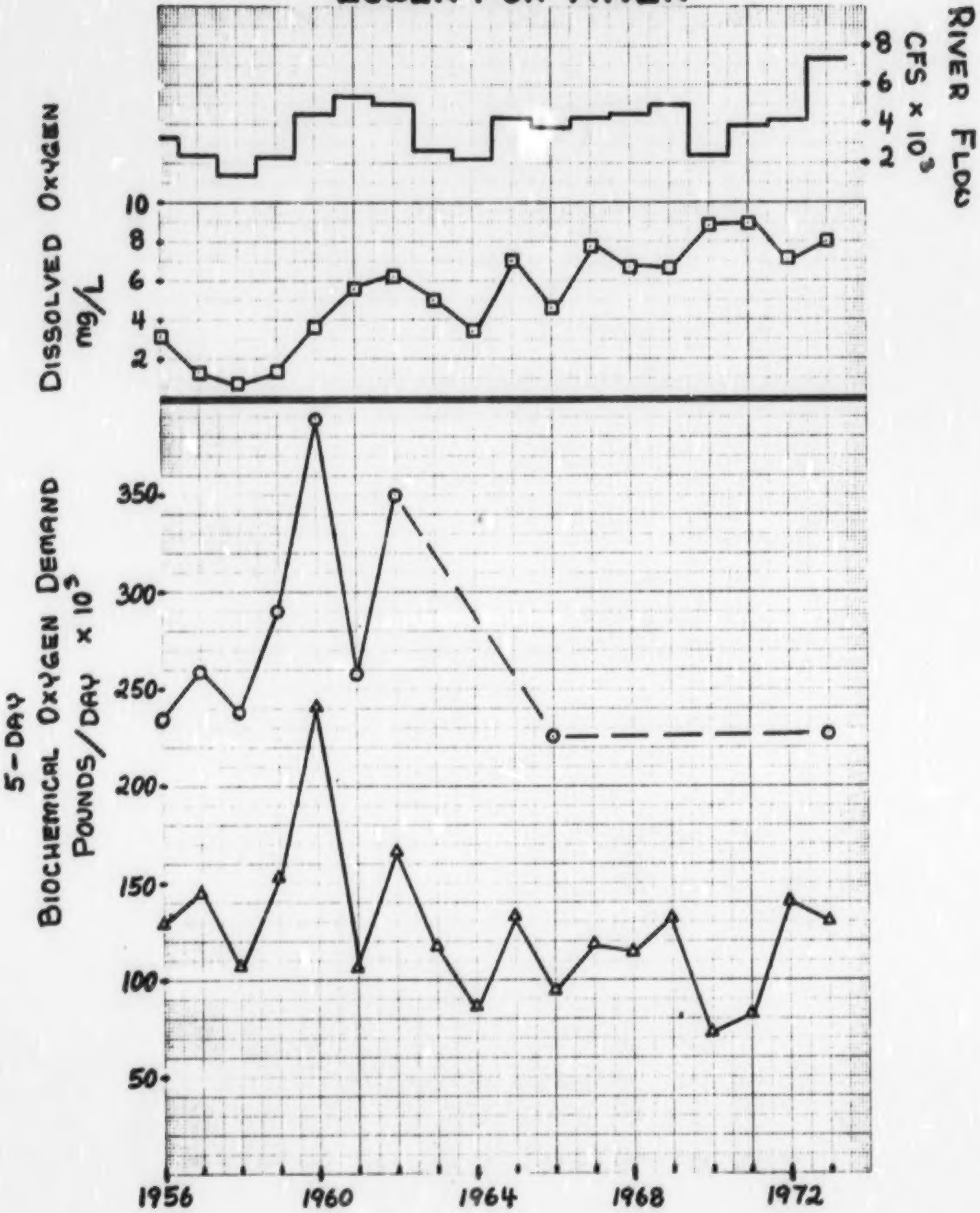
Position	Date	Depth, feet	Dissolved Oxygen, p.p.m.	Tempera- ture, °C.	Per Cent Saturated	Biochemical Oxygen Demand, p.p.m.	Total Alkalinity, p.p.m.	pH
79	9-2-55	32 Bottom	3.9	19.6	42	0.0	0+118	8.0
		15	6.9	22.0	78	0.0	0+116	8.5
		Surface	8.1	21.8	91	0.9	0+120	8.5
82	9-2-55	42 Bottom	6.3	18.2	66	0.5	0+119	7.9
	9-2-55	20	7.1	21.4	80	0.5	0+120	8.3
	9-2-55	Surface	7.9	22.2	90	0.7	0+116	8.5
84	9-2-55	45 Bottom	4.8	18.8	57	1.0	0+118	7.7
	9-2-55	20	7.7	22.0	57	1.1	0+116	8.4
	9-2-55	Surface	8.5	22.0	96	1.3	0+118	8.5
86	9-2-55	52	3.6	17.0	37	0.6	0+115	7.5
91	9-12-55	88 Bottom	5.6	10.2	44	1.0	—	—
	9-12-55	40	7.7	18.0	81	0.8	—	—
	9-12-55	Surface	8.6	17.1	88	0.6	—	—
	9-12-55	30 Bottom	8.3	17.0	85	0.6	—	—
	9-12-55	Surface	8.6	17.0	88	1.2	—	—

Balch et al, 1956

APPENDIX XI

Lower Fox, Oconto, Peshtigo and Menominee Rivers - BOD Loadings to Lower Green Bay, 1956-1973

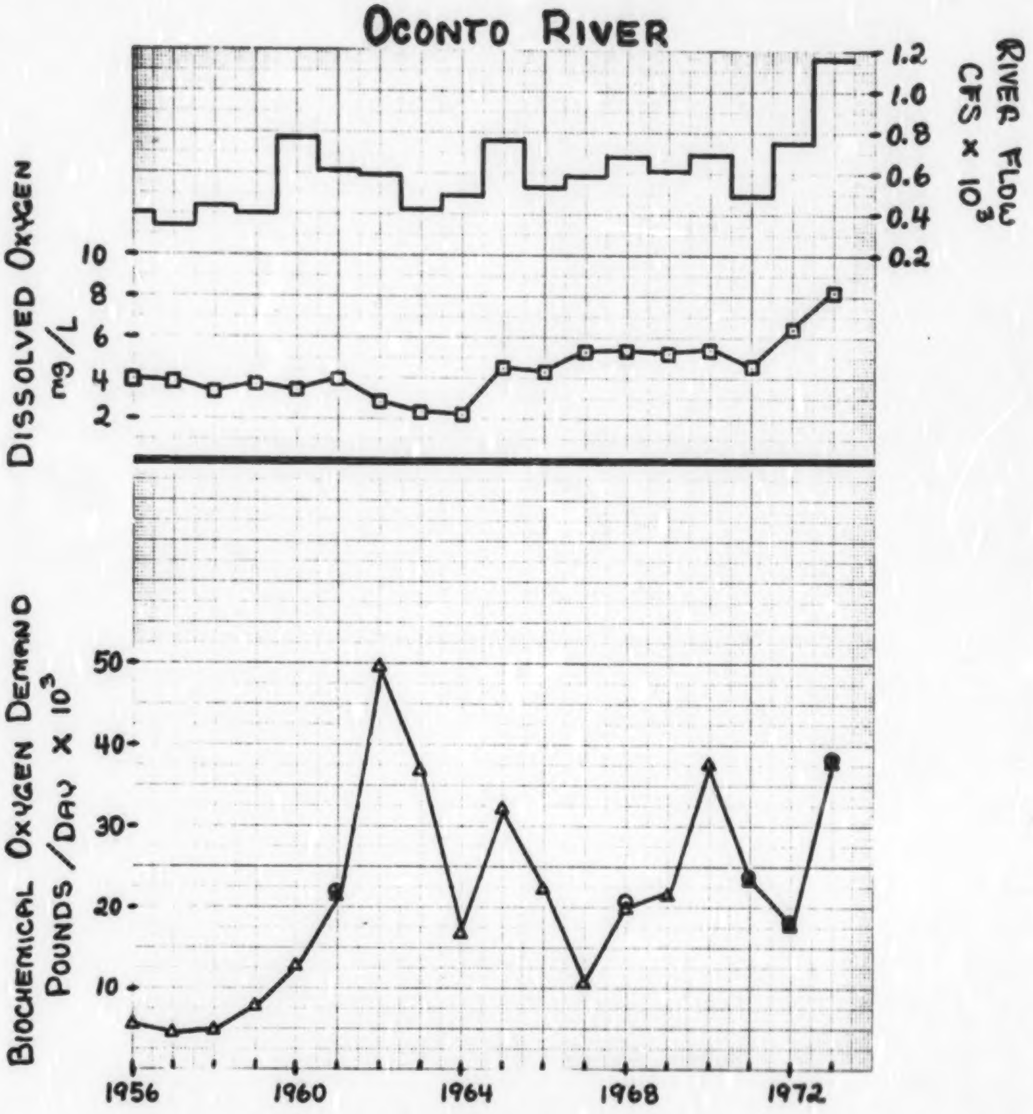
LOWER FOX RIVER



△ Actual River Loading - River Mile 1.4 (1956-60)
" " 2.3 (1961-73)

○ Estimated Total River Loading at River Mile 0.0

1956-60 Data - Averages for Summer Months Only

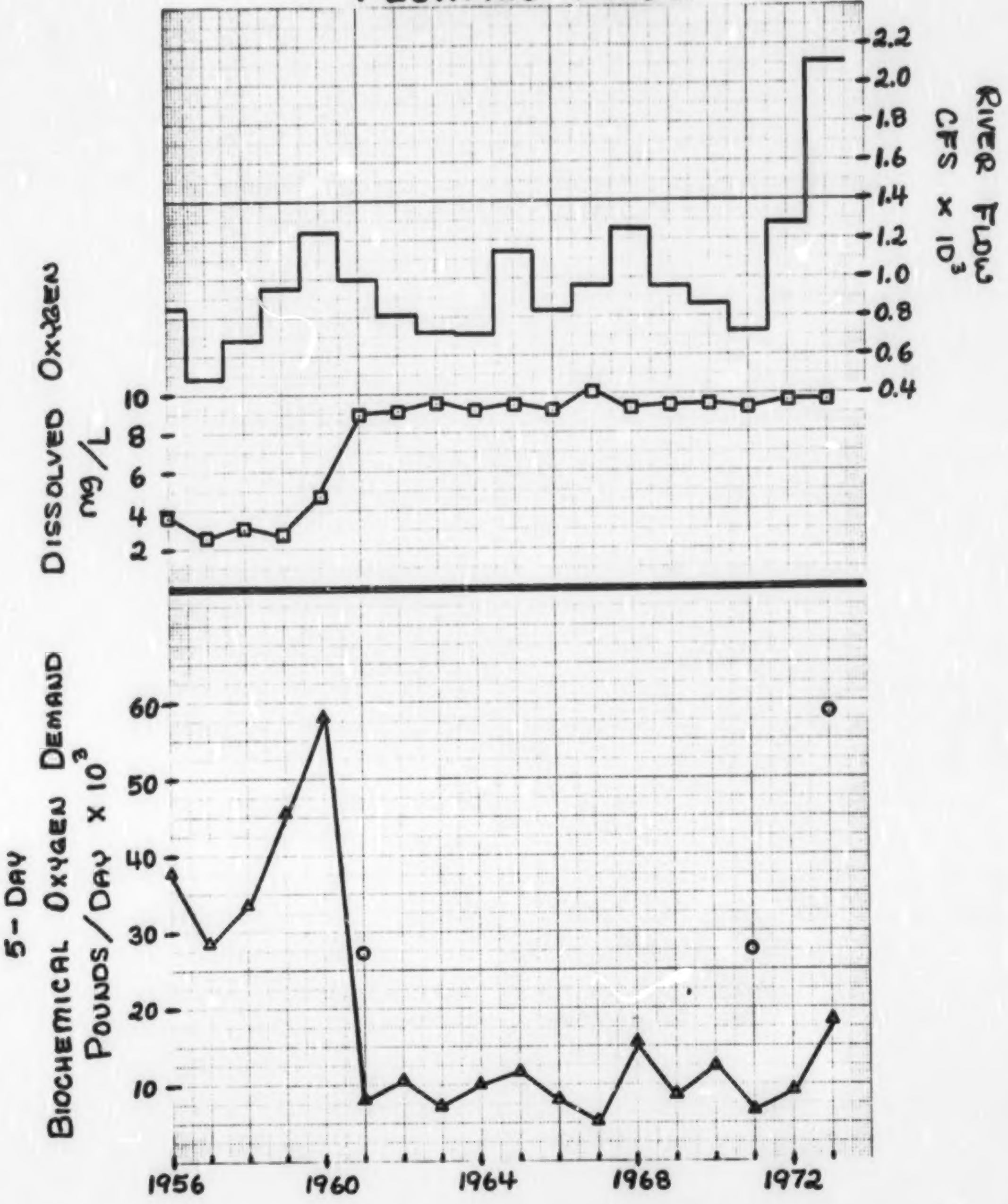


△ Actual River Loading - River Mile 3.1 (1956-73)

○ Estimated Total River Loading at River Mile 0.0

1956-60 Data - Averages for Summer Months Only

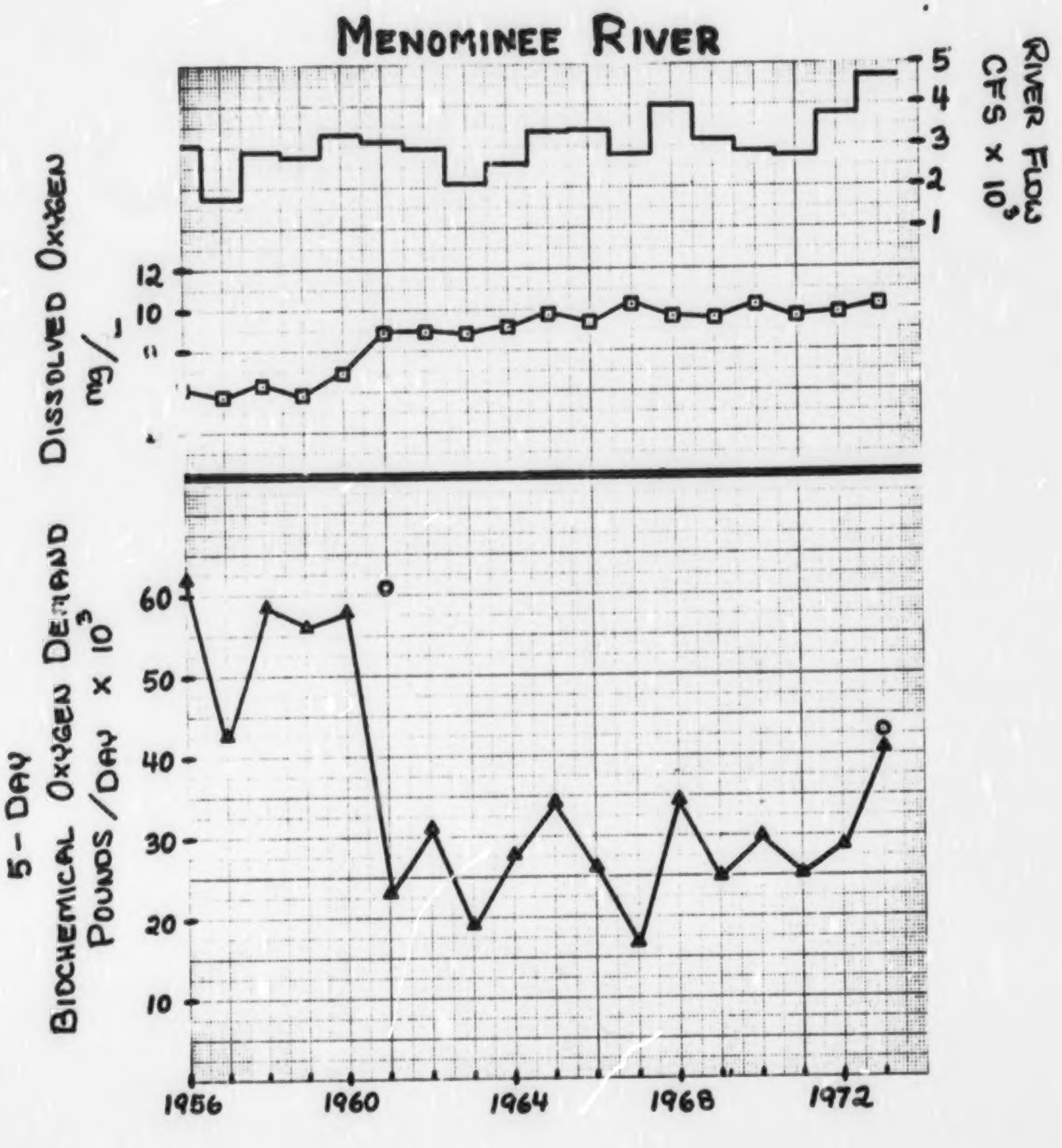
PESHTIGO RIVER



△ Actual River Loading - River Mile 1.0 (1956-60)
" " 10.5 (1961-73)

○ Estimated Total River Loading at River Mile 0.0

1956-60 Data - Averages for Summer Months Only



MENOMINEE RIVER

△ Actual River Loading - River Mile 1.7 (1956-60)
" " 3.5 (1961-73)

○ Estimated Total River Loading at River Mile 0.0

1956-60 Data - Averages for Summer Months Only

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